JOURNAL
OF
ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 9 FEBRUARY, 1916 No. 1

Proceedings of the Twenty-eighth Annual Meeting of the American Association of Economic Entomologists

The twenty-eighth annual meeting of the American Association of Economic Entomologists was held in the Botany and Zoölogy Building at the Ohio State University at Columbus, O., December 27 to 30, 1915.

The first session was held at 1.30 p. m., December 27, when annual reports were given and the address of the President was delivered.

The meeting of the section on Apiary Inspection was held at 8.00 p. m., December 27, at the Southern Hotel. The meeting of the section on Horticultural Inspection was held at 8.00 p. m., December 28, in the House of Representatives in the State Capitol and a session on the following morning was held at the State University.

The business proceedings of the Association are given as Part 1 of this report and the addresses, papers and discussions will be found in Part 2.

The proceedings of the sections will be prepared by the section secretaries and published as parts of this report.

A large attendance was present at the meeting and the program was varied and very interesting.

PART 1. BUSINESS PROCEEDINGS

The meeting was called to order by President Glenn W. Herrick at 1.30 p. m., Monday, December 27, 1915.

About 150 members and visitors attended the sessions. The following members were present:

C. N. Ainslie, Elk Point, S. D.
Geo. G. Ainslie, Nashville, Tenn.
J. M. Aldrich, Lafayette, Ind.
H. W. Allen, Melrose Highlands, Mass.
I. L. Bailey, Northboro, Mass.
G. G. Becker, Fayetteville, Ark.
G. M. Bentley, Knoxville, Tenn.
A. H. Beyer, Washington, D. C.
S. W. Bilsing, College Station, Tex.
M. W. Blackman, Syracuse, N. Y.
A. F. Burgess, Melrose Highlands, Mass.
J. W. Chapman, Forest Hills, Mass.
Mel T. Cook, New Brunswick, N. J.
E. C. Cotton, Elyria, Ohio.
C. R. Crosby, Ithaca, N. Y.
J. J. Davis, Lafayette, Ind.
Geo. A. Dean, Manhattan, Kan.
H. F. Deitz, Indianapolis, Ind.
M. W. Eddy, State College, Pa.
W. E. Evans, Jr., Painesville, Ohio.
H. E. Ewing, Ames, Iowa.
E. P. Felt, Albany, N. Y.
F. A. Fenton, West Lafayette, Ind.
S. B. Fracker, Madison, Wis.
B. B. Fulton, Geneva, N. Y.
Hugh Glasgow, Geneva, N. Y.
W. H. Goodwin, Wooster, Ohio.
H. A. Gossard, Wooster, Ohio.
W. P. Hayes, Manhattan, Kan.
T. J. Headlee, New Brunswick, N. J.
G. W. Herrick, Ithaca, N. Y.
C. Gordon Hewitt, Ottawa, Canada.
J. S. Hine, Columbus, Ohio.
J. S. Houser, Wooster, Ohio.
L. O. Howard, Washington, D. C.
N. F. Howard, Columbus, Ohio.
S. J. Hunter, Lawrence, Kan.
H. H. Jewett, Lexington, Ky.
V. L. Kellogg, Stanford University, Cal.
J. L. King, Cleveland, Ohio.
Max Kislink, Jr., Washington, D. C.
W. H. Larrimer, Wellington, Kan.
F. H. Lathrop, Geneva, N. Y.
R. W. Leiby, Raleigh, N. C.
A. D. MacGillivray, Urbana, Ill.
P. W. Mason, Lafayette, Ind.
J. W. McColloch, Manhattan, Kan.
E. W. Mendenhall, Clintonville, Ohio.
G. B. Merrill, North Abington, Mass.
J. H. Merrill, Manhattan, Kan.
C. L. Metcalf, Columbus, Ohio.
Z. P. Metcalf, Raleigh, N. C.
Wm. Moore, St. Paul, Minn.
Wilmon Newell, Gainesville, Fla.
Henry Ness, Ames, Iowa.
F. M. O'Bryne, Gainesville, Fla.
W. C. O'Kane, Durham, N. H.
W. A. Osgood, Durham, N. H.
Herbert Osborn, Columbus, Ohio.
F. B. Paddock, College Station, Tex.
J. R. Parker, Bozeman, Mont.
T. H. Parks, Ashville, Ohio.
Edith M. Patch, Orono, Me.
L. M. Peairs, Morgantown, W. Va.
F. C. Pellett, Atlantic, Iowa.
Alvah Peterson, Urbana, Ill.
Morley Pettit, Guelph, Canada.
E. F. Phillips, Washington, D. C.
W. J. Phillips, Charlottesville, Va.
F. W. Rane, Boston, Mass.
W. A. Riley, Ithaca, N. Y.
A. H. Rosenfeld, Tucuman, Argentina.
A. G. Ruggles, St. Paul, Minn.
W. E. Rumsey, Morgantown, W. Va.
J. G. Sanders, Madison, Wis.
E. R. Sasscer, Washington, D. C.
A. F. Satterthwait, Lafayette, Ind.
W. J. Schoene, Blacksburg, Va.
G. D. Shafer, East Lansing, Mich.
N. E. Shaw, Columbus, Ohio.
V. E. Shelford, Urbana, Ill.
F. L. Simanton, Benton Harbor, Mich.
M. P. Somes, Mountain Grove, Mo.
H. J. Speaker, Sandusky, Ohio.
J. Edward Taylor, Salt Lake City, Utah.
F. L. Thomas, Auburn, Ala.
James Troop, Lafayette, Ind.
T. D. Urbanus, Washington, D. C.
Joe S. Wade, Wellington, Kan.
F. M. Webster, Washington, D. C.
R. L. Webster, Ames, Iowa.
Don B. Whelan, East Lansing, Mich.
R. D. Whitmarsh, Wooster, Ohio.
G. C. Woodin, East Lansing, Mich.
L. H. Worthley, Boston, Mass.

PRESIDENT GLENN W. HERRICK: You will please come to order. The first business on the program is the report of the Secretary.

REPORT OF THE SECRETARY

At the time of the last Annual Meeting of the Association the membership consisted of 133 active, 212 associate and 52 foreign members, making a total of 397. At that meeting one active member resigned and seven associate members were transferred to the active list. Since the meeting one active member has died and three have been dropped for non-payment of dues. At the time of the meeting two associate members resigned and 66 new associate members were elected. Since that time two have been dropped for non-payment of dues. The present membership is as follows: Active, 135; associate, 267; foreign, 52, making a total of 454.

Since our last meeting Mr. Harry M. Russell, who for a number of years has been employed by the Bureau of Entomology, has been removed by death. Mr. Russell was born in Bridgeport, Conn., March 30, 1882; graduated from the Bridgeport High School in 1901 and from the Massachusetts Agricultural College in 1906. He died at Phoenix, Ariz., June 25, 1915. Mr. Russell was an excellent worker in economic entomology and his loss will be greatly felt.

On August 9–10, 1915, a special meeting of the Association was held at Berkeley, Cal. The meeting was very successful, members attending who are usually unable to be present at the annual meeting. The Secretary attended the meeting and was greatly impressed with the enthusiasm and zeal with which the members in the western states are meeting the many difficult entomological problems which must be solved.

At the Berkeley meeting, several sessions of which were held jointly with the Pacific Coast Association of Economic Entomologists, the desire was expressed by that association to become affiliated with this Association and a committee was appointed to consider the matter. A report of this committee will be found in the October number of the JOURNAL. A recommendation for making a minor modification of the constitution so as to bring this affiliation about is suggested by the committee for action at this meeting.

The finances of the Association have improved since the last annual meeting and at the present time we have a generous surplus on hand. This has been brought about by the slight increase in the amount of dues provided for at the last meeting and also because a considerable portion of the 1916 dues have already been paid.

THE JOURNAL OF ECONOMIC ENTOMOLOGY

The increase in Association dues was coupled with a slight advance in the subscription price of the JOURNAL and this has been very beneficial to that publication. It has been possible to accept more papers for publication and print them more promptly than heretofore. This should be appreciated by the members and subscribers.

During the past year the net increase in the subscription list has amounted to 44. Although there have been many cancellations of foreign subscriptions, there was a net increase of three during the year. The number of subscriptions to the JOURNAL should be still further increased. If the members will interest themselves in new subscribers the list ought to extend very materially.

Association Statement

Balance in Treasury, December 22, 1914		$262.34
By amount received for dues, 1915		631.00
By amount received from Section on Apiary Inspection		3.25
By amount received from interest		14.31
To stenographic report 1914 meeting	$88.32	
Stamps and stamped envelopes	46.51	
Printing announcements, etc.	63.55	
Telegraph and express	5.29	
Miscellaneous supplies	1.00	
Clerical work, Secretary's office	34.92	
One-half salary of Secretary	50.00	
	$289.59	
Balance, December 23, 1915	621.31	
	$910.90	$910.90

Balance deposited as follows:

Melrose Savings Bank	$145.46
Malden National Bank	475.85

Journal Statement

Balance in Treasury, December 22, 1914		$396.41
By amount received for subscriptions, advertising, etc., 1915		2,376.34
To stamps and stamped envelopes	$52.64	
Printing	1,530.59	
Halftones	150.87	
Miscellaneous supplies	38.40	
Refunds on subscriptions	4.00	
Returned checks	5.60	
Clerical work, Editor's office	50.00	
Clerical work, Manager's office	35.63	
Salary, Editor	100.00	
One-half salary of Manager	50.00	
	$2,017.73	
Balance December 23, 1915	755.02	
	$2,772.75	$2,772.75

Deposited in Malden National Bank $755.02

Respectfully submitted,

A. F. BURGESS,
Secretary.

On motion the report was accepted and the financial part referred to the auditing committee.

SECRETARY A. F. BURGESS: I would like to make a brief statement in regard to the JOURNAL. During the past year there has been an increase in the subscription list of 44 so that we now have 764 subscribers. The number would be materially increased if the members would interest themselves in securing a few new subscribers. Although a large number of foreign subscriptions have been cancelled through

the year, enough new ones have been secured so that a net gain of three has resulted. I hope the members of the Association will endeavor during the coming year to increase our subscription list.

PRESIDENT GLENN W. HERRICK: I will now read the report of the executive committee but before doing so will ask Prof. F. M. Webster to occupy the chair.

REPORT OF THE EXECUTIVE COMMITTEE

The Association received an invitation from the Honorable William J. Bryan, Secretary of State, to participate in the Second Pan-American Scientific Congress which is now meeting in Washington, D. C. In response to this invitation, the President appointed Doctor C. L. Marlatt of Washington, as delegate, and Doctor W. J. Holland of Pittsburg, because of his wide acquaintance with the South American scientific men, as alternate delegate. Both of these men accepted and expressed their intention of attending the meeting.

The Special summer meeting of the Association was held at Berkeley, California, August 9 and 10, in accordance with the decision of the Association made at the last annual meeting at Philadelphia. This was a very profitable and interesting meeting but, unfortunately, was not attended by as many eastern entomologists as could have been wished. The first Vice-President presided in the absence of the President who was not able to be present.

The Executive Committee has been charged with the responsibility of selecting a design for a seal for the Association. The chairman has corresponded regarding the matter with the other members of the committee, and with several of the older members of the Association to obtain ideas and suggestions. Those who favor the profile of an insect for the seal argue for the Rocky Mountain locust and Colorado potato beetle. The majority of those with whom we have communicated do not favor the profile of an insect but are rather overwhelmingly in favor of the profile of Harris, the father of economic entomology. We quote briefly; the first "thinks the suggestion of Harris' profile is a most excellent one. Personally, I have got rather tired of these seals displaying an insect." Another says, "I do not think it wise to select any single species of insect for a seal for the Association of Economic Entomologists. I should by all means favor a relief of Harris' profile." To a third, "It seemed questionable whether an insect should be used"; while a fourth is not "keen for any insect in the seal" and prefers the profile of Harris. Another says, "As a central idea, I have thought over many things but nothing comes to me more appropriate than the portrait of the first official entomologist in America, the country in which economic entomology had its beginnings." As a final suggestion, the following from one of our oldest members is well worth serious consideration; "A plain seal with the name of the Association and the date of incorporation should be all that is necessary, and perhaps will be in better taste and much cheaper than one which carries what might be termed "*An appropriate design.*"

The Executive Committee does not care to make a definite recommendation regarding the design but believes it would be wise for the Association to settle the question at this meeting.

GLENN W. HERRICK,
W. E. RUMSEY,
E. F. PHILLIPS,
A. F. BURGESS,
Executive Committee.

MR. F. M. WEBSTER: You have heard the report of the executive committee. What action do you wish to take? On motion the report was adopted as presented. A general discussion followed in regard to the adoption of an official seal and it was voted to defer final decision until the last session of the meeting.

PRESIDENT GLENN W. HERRICK: The next on the program is the report of the employment bureau which in the absence of Dr. Hinds will be read by the secretary.

ANNUAL REPORT OF ENTOMOLOGIST'S EMPLOYMENT BUREAU

December 27, 1915.

GENERAL STATEMENT

During the past year the Employment Bureau has received thirty-two new enrollments. These, with the names carried over from 1914, make about fifty men now on the roll. These names represent all grades of experience and equipment, from those just beginning in entomological work to men who have had extended opportunities and achieved international reputations.

During 1915 a general effort for economy was manifested throughout the United States, and would seem to have been responsible, in some measure at least, for both the large number of enrollments and the small number of changes or new positions which have come to our attention during the year. Six men appear to have been placed through information given by the Bureau, and two or three other positions are now in process of being filled. During the year some six hundred and fifty letters have been sent out in the work of the Bureau.

We would repeat suggestions made last year in regard to the need for candidates to keep us in closer touch with their changes of address and new lines of work. We would urge also that it will multiply the usefulness of the Bureau if employers will give us more general opportunity to supply them with the addresses of men who would seem to have the qualifications required for any entomological positions that they may have to fill.

One difficulty or limitation in the work of the Bureau may be found in the fact that all United States Department of Agriculture appointments are based upon Civil Service examinations. Thus the largest employer of entomological labor, The United States Bureau of Entomology, is practically placed outside of the field of work of the Employment Bureau. While many of our enrolled men have taken Civil Service examinations and may receive appointments in the Bureau of Entomology, the Employment Bureau cannot, under present arrangements, perform any service in bringing these parties together.

The financial statement for 1915 is appended hereto.

FINANCIAL STATEMENT OF THE BUREAU

	Dr.	
Cash on hand January 1, 1915	$27.01	
To 32 enrollment fees at $2	64.00	
Total receipts		$91.01

	Cr.	
March 20, 1915, to multigraphing letters (voucher 1)	$ .60	
May 20, multigraphing letters (voucher 2)	.40	
July 10, by typewriter paper, W. E. Hinds cash (voucher 3)	1.20	
August 6, postage (voucher 4)	10.00	
August 25, stenographic work N. C. Powell (voucher 5)	18.50	
December 3, multigraphing work (voucher 6)	.75	
December 22, stenographic work (voucher 7)	10.00	
December 22, W. E. Hinds cash, postage and stationery (voucher 8)	4.86	
Total		46.31
Balance cash on hand December 22, 1915		$44.70

W. E. HINDS,
In Charge.

On motion the report of the employment bureau was accepted and the financial part referred to the auditing committee. It was also voted that a general consideration of the work of the employment bureau be taken up at the final session.

PRESIDENT GLENN W. HERRICK: We will now hear the report of the committee on nomenclature by Prof. Herbert Osborn.

TO THE ASSOCIATION ECONOMIC ENTOMOLOGISTS

At the last meeting of the Association, your committee on nomenclature presented without recommendation a request from Dr. H. J. Franklin that the names of the black-head cranberry worm, *Rhopobota vacciniana*, and the yellow-head cranberry worm, *Peronea minuta* be changed to the Flowed-bog fire worm and the dry-bog fire worm respectively. By action of the Society the matter was referred back to the committee with instructions to secure additional information and to determine the desires of those interested in the cranberry insects in different parts of the country. In accordance with these instructions, the committee has received during the year a request from Dr. Franklin and others interested in the matter requesting that instead of the former names and the names proposed last year, the name black-head fire worm be used for *Rhopobota vacciniana* and the yellow-head fire worm for *Peronea minuta*. As these names seem to satisfiy the persons most interested, including Dr. Franklin, members of the Bureau of Entomology and the President of the Cranberry Growers Association, the committee respectfully recommends that they be adopted and recommended for general use in place of the names hitherto adopted by the Society.

HERBERT OSBORN,
W. E. BRITTON,
E. P. FELT,
Committee.

After a brief discussion it was voted to accept the report of the committee and adopt the names as suggested in that report.

PRESIDENT GLENN W. HERRICK: As the report of the committee on entomological investigations has not been received and as the chair-

man of the committee on bibliography of economic entomology has been delayed in reaching the meeting, the latter report will be considered at the final session of the meeting.

I will now appoint the committees:

The Committee on Auditing—T. J. Headlee and C. R. Crosby.

The Committee on Resolutions—Geo. A. Dean, W. C. O'Kane, S. J. Hunter.

The Committee on Nominations—E. P. Felt, R. L. Webster, H. A. Gossard.

Are there any matters to be considered under miscellaneous business?

SECRETARY A. F. BURGESS: Some difficulty is experienced each year in arranging the program for the meeting and a considerable number of members usually fail to send in their titles before the time limit for receiving titles expires. This has caused considerable disappointment among the members and I would, therefore, move that a committee of three be appointed to consider the matter of program so that the secretary may conform strictly to the wishes of the Association in preparing future programs.

MR. HERBERT OSBORN: In studying the program I notice that a paper is scheduled by Dr. Howard before this Association at the same time that one is to be presented by Professor Webster before the Entomological Society of America. It seems to me it might be possible to arrange the program for both societies so that all the members could hear these papers. This committee should confer with the committee of the Entomological Society of America and see if this can be brought about.

After a general discussion it was voted that the committee be appointed to take up both of these matters and report on the rearrangement of the program at the Tuesday morning session.

PRESIDENT GLENN W. HERRICK: I will appoint the following committee: Herbert Osborn, F. M. Webster and H. A. Morgan. It is also necessary to appoint a committee to consider the proposed amendments to the constitution and by-laws and I will ask the following men to serve on this committee: J. M. Aldrich, J. G. Sanders, E. F. Phillips.

At the opening session Tuesday morning the committee on program recommended that the officers of the association be authorized to arrange with the officers of the Entomological Society of America for a joint session Thursday morning so that the members of both societies could hear the papers by Dr. Howard and Professor Webster; also that papers received after the program closed be placed at the end of the program and that the other papers be advanced on the program as rapidly as time permits. It was voted to accept the report of the committee.

PRESIDENT GLENN W. HERRICK: Mr. Felt, as chairman of the nominating committee, has called my attention to the fact that the members who were elected last year to serve as councillors to the American Association for the Advancement of Science are not present at this meeting. The committee suggests that W. A. Riley and H. A. Morgan be designated to serve in this capacity. It was voted to accept the recommendations of the committee.

MR. F. M. WEBSTER: As most of you know, Professor Summers, one of the older members of our Association, is very sick. I would, therefore, move that the secretary be instructed to send a telegram to Professor Summers extending the sympathy of the Association. Adopted.

The final business session was held Thursday morning, December 30.

PRESIDENT GLENN W. HERRICK: We will now listen to the report of the committee on auditing.

REPORT OF THE AUDITING COMMITTEE

COLUMBUS, O., December 30, 1915.

To the American Association of Economic Entomologists:

This is to certify that the undersigned, your committee on audit, has examined the accounts of the Treasurer including those of the association proper and of the JOURNAL, and has found them to be satisfactory and correct.

This is to certify, further, that your Committee has examined the accounts of the Entomologist's Employment Bureau and has found them to be correct.

THOMAS J. HEADLEE,
C. R. CROSBY,
Auditors.

On motion the report was accepted.

PRESIDENT GLENN W. HERRICK: We will next listen to the report of the committee on resolutions.

REPORT OF THE COMMITTEE ON RESOLUTIONS

Your Committee submits the following:

I. The Association desires to express to Professor Herbert Osborn and his associates, Professor H. A. Gossard and his associates, Mr. N. E. Shaw and his associates and all other entomologists of Ohio, and to the Ohio State University, its hearty gratitude for their cordial hospitality and for the admirable facilities provided by them for the association meetings.

II. WHEREAS, the Index of American Economic Entomology covers a decade of most productive work and is nearly indispensable to every economic entomologist, therefore be it, *Resolved*, that, in view of the great utility of this compilation, the Secretary of Agriculture, through the Bureau of Entomology, be most strongly urged to arrange for its speedy publication.

GEO. A. DEAN,
WALTER C. O'KANE,
S. J. HUNTER,
Committee.

It was voted that the report be accepted.

PRESIDENT GLENN W. HERRICK: The report of the committee on membership is next in order.

REPORT OF THE COMMITTEE ON MEMBERSHIP

The committee on membership recommend:

(1) That the following named persons be elected to associate membership:

Walter Wellhouse, Lawrence, Kan.
Don B. Whelan, East Lansing, Mich.
Asa C. Maxson, Longmont, Colo.
Geo. H. Vansell, Lexington, Ky.
Frank M. O'Byrne, Gainesville, Fla.
James G. Needham, Ithaca, N. Y.
H. J. Speaker, Sandusky, Ohio.
Paul R. Myers, Hagerstown, Md.
Simon Marcovitch, University Farm, St. Paul, Minn.
Frank Mervyn Littler, Launceston, Tasmania.
James Calvin Goodwin, College Station, Texas.
Howard H. Jewett, Lexington, Ky.
E. O. Essig, Berkeley, Cal.
Morley Pettit, Guelph, Ont.
Frank H. Lathrop, Geneva, N. Y.
Max. Kislink, Jr., Washington, D. C.
Stanley Black Fracker, Madison, Wis.
C. L. Scott, Wellington, Kan.
Joseph Douglas Hood, Washington, D. C.
Jesse R. Christie, College Park, Md.
Ed. L. Ayers, Austin, Texas.
Edwin Cooper Van Dyke, Berkeley, Cal.
W. M. Gifford, Honolulu, Hawaii.
O. W. Rosewall, Baton Rouge, La.
E. A. Vaughn, Auburn, Ala.
Frederick Azel Fenton, West Lafayette, Ind.
Jerauld A. Manter, Storrs, Conn.
Olden Key Courtney, College Station, Texas.
J. Edward Taylor, Salt Lake City, Utah.
H. Gordon Crawford, Wilton Grove, Ontario, Canada.
Loren B. Smith, Blacksburg, Va.

(2) That the following named persons be transferred from associate to active membership:

G. M. Bentley, Knoxville, Tenn.
C. W. Collins, Melrose Highlands, Mass.
D. T. Fullaway, Honolulu, Hawaii.
W. H. Goodwin, Wooster, Ohio.
F. Z. Hartzell, Geneva, N. Y.
C. L. Metcalf, Columbus, Ohio.
E. R. Sasscer, Washington, D. C.

(3) That by his request Mr. P. B. Gregson, Reesland, Rosemount, Romford, Essex, England, be transferred from active to associate membership.

(4) That the following resignations be accepted:

H. G. Dyar, Washington, D. C.
I. J. Condit, Berkeley, Cal.
R. W. Hegner, Ann Arbor, Mich.
C. P. Smith, College Park, Md.
H. E. Weed, Beaverton, Ore.
P. S. Welch, Manhattan, Kan.

(5) That the Secretary be instructed to notify the four active and the six associate members who are in arrears for dues for two years that if such dues are not paid within three months their names will be dropped from the roll.

Respectfully submitted,

WILMON NEWELL,
WALTER C. O'KANE,
J. G. SANDERS,
Committee.

By vote of the Association the report was accepted and the recommendations adopted.

PRESIDENT GLENN W. HERRICK: We will now pass to the report of the committee on amendments to the constitution.

REPORT OF THE COMMITTEE ON CONSTITUTIONAL AMENDMENTS

The Committee on Constitutional Amendments beg leave to report that they have considered the proposed amendments as printed in the program, and recommend that they be adopted.

Respectfully submitted,

J. M. ALDRICH,
J. G. SANDERS,
E. F. PHILLIPS,
Committee.

PRESIDENT GLENN W. HERRICK: Is there any discussion of this report?

MR. W. C. O'KANE: I would like to ask for a statement in regard to the first amendment which is proposed:

SECRETARY A. F. BURGESS: Perhaps I can explain this matter better than anyone present as I attended the summer meeting at Berkeley, Cal. At that meeting the Pacific Slope Association of Economic Entomologists held several joint sessions with this Association and they asked that a joint committee be appointed to consider what could be done in bringing about an affiliation of that association with ours. A committee was appointed and the matter was considered and a report of it will be found in the October number of the JOURNAL. The sentiment at that meeting was very favorable toward becoming affiliated with this Association, although it was explained that this Association could not act definitely on the matter at that meeting. In order to bring about the affiliation it seemed necessary to slightly amend our constitution so that the Pacific Slope Association could become a branch of this Association. Our constitution at present provides for sections which are based on projects or activities such as nursery inspection, apiary inspection, etc. The term "branch" would refer to geographical divisions of the country and seemed to be more appropriate than to use the word "section" for such a division. I sincerely hope the amendment will be accepted as proposed by the committee. I think it is a step in the right direction as it will bring together all the economic entomologists in the country under one strong association. The men I conferred with on the coast were anxious to see the matter acted upon favorably and I think this is the logical thing for us to do.

By vote of the Association the amendments were accepted as recommended by the committee.

AMENDMENTS TO THE CONSTITUTION.

Section I, Article III, insert the words "branch or" before the word "section" in line two so that the first sentence of Section I will read as follows: "The officers shall consist of a president, one vice-president and an additional vice-president for each branch or section who shall be elected annually, and a secretary who shall be elected for a term of three years, who shall perform the duties customarily incumbent upon their respective offices and as defined in the by-laws."

Add a new section to Article II as follows: "Section IV. The publication of the JOURNAL OF ECONOMIC ENTOMOLOGY shall be entrusted to an editor, an associate editor and a business manager nominated by an advisory committee of six members, which latter shall be elected for terms of three years so arranged that two shall be elected annually. The members of this committee shall have an advisory relation to the above constituted editorial board."

On motion of Mr. E. P. Felt the executive committee was authorized to accept and take the necessary action on the application of the Pacific Slope Association of Economic Entomologists as a branch of this Association.

PRESIDENT GLENN W. HERRICK: The next business on the program is the nomination of JOURNAL officers by the advisory board. Only one member of this board is here and he has had no time to give attention to this matter. It has been suggested that the Association by general motion elect the officers as it is necessary that the matter be acted on at this time.

MR. C. GORDON HEWITT: I move that the present officers of the JOURNAL be elected for the ensuing year.

The motion was unanimously adopted.

PRESIDENT GLENN W. HERRICK: I now call for the report of the committee on index of economic entomology.

REPORT OF THE COMMITTEE ON THE PUBLICATION OF THE INDEX OF AMERICAN ECONOMIC ENTOMOLOGY

It is a pleasure to state that, through the coöperation of Dr. L. O. Howard and the untiring efforts of Dr. Nathan Banks, this important work will be completed shortly. Dr. Banks, who has had immediate charge of the undertaking, states that about 24,000 references have been entered and fully 1,000, possibly 2,000 or more from the less important agricultural journals are yet to be assembled. He is of the opinion that the work can be completed possibly in one, and certainly in two months. The index will make, if printed as planned in ten point type, double column, a publication of approximately 250 pages. This is more than was estimated in December 1914 and just about the size of the bibliography as planned in 1913.

There is no question as to the great utility of this work and we feel that it marks a distinct advance in reference literature. Your committee recommends that the undertaking be pushed to an early completion and that in the event of its being impossible to find any other satisfactory publishing agency, that the American Association of Economic Entomologists issue the index in accordance with the plan outlined in the report which was submitted and favorably acted upon at the Atlanta meeting.

Furthermore, the committee would recommend, as a slight recognition of the work done by Dr. Banks upon this project, that his membership dues and subscription to the JOURNAL OF ECONOMIC ENTOMOLOGY be remitted for a period of five years.

Respectfully submitted

E. P. FELT,
A. F. BURGESS,
W. C. O'KANE,
W. E. BRITTON,
W. E. HINDS,
Committee.

MR. S. J. HUNTER: I move the adoption of the report as read by the committee. Carried.

PRESIDENT GLENN W. HERRICK: It was voted at the opening session to consider the work of the employment bureau at this time.

After a general discussion it was voted that the executive committee request the director of the employment bureau to prepare a report covering the work of the bureau since its establishment for consideration at the next annual meeting of the Association.

PRESIDENT GLENN W. HERRICK: The final report of the committee on program should be given at this time but as it has not been received suggestions concerning future programs are in order.

A general discussion followed and the concensus of opinion seemed to be that the secretary should arrange with the secretary of the Entomological Society of America to avoid as much as possible the overlapping of the programs.

A motion to reduce the maximum length of time for the delivery of a paper from fifteen to ten minutes was discussed but the motion was lost.

PRESIDENT GLENN W. HERRICK: We will now hear the report of the committee on nominations.

REPORT OF THE COMMITTEE ON NOMINATIONS[1]

The committee recommends the election of the following:

For President, C. Gordon Hewitt, Ottawa, Can.

For First Vice-President, G. A. Dean, Manhattan, Kan.

For Second Vice-President (Pacific Coast Branch), E. D. Ball, Logan, Utah.

For Third Vice-President (Horticultural Inspection), W. J. Schoene, Blacksburg, Va.

For Fourth Vice-President (Apiary Inspection), T. J. Headlee, New Brunswick, N. J.

For Committee on Nomenclature, W. E. Britton, New Haven, Conn.

[1]The Second Vice-President has been approved by the Board of Directors to complete the organization of the Pacific Coast Branch.

The Board of Directors also appointed Prof. V. L. Kellogg a member of the Advisory Committee of the JOURNAL OF ECONOMIC ENTOMOLOGY to fill the vacancy caused by the death of Prof. F. M. Webster (*Secretary*).

For Committee on Entomological Investigations, H. T. Fernald, Amherst, Mass.
For Committee on Membership, J. J. Davis, Lafayette, Ind.
For Councillors to the American Association for the Advancement of Science, C. P. Gillette, Ft. Collins, Col., G. W. Herrick, Ithaca, N. Y.
For Director of Entomologist's Employment Bureau, W. E. Hinds, Auburn, Ala.
For the Advisory Board of the JOURNAL OF ECONOMIC ENTOMOLOGY, C. P. Gillette, Fort Collins, Col., W. E. Hinds, Auburn, Ala.

Respectfully Submitted,

E. P. FELT,
R. L. WEBSTER,
H. A. GOSSARD,
Committee.

By vote of the Association the secretary was instructed to cast one ballot for the officers mentioned in the report. The ballot was cast and they were declared elected.

PRESIDENT GLENN W. HERRICK: Is there anything else under the head of miscellaneous business?

SECRETARY A. F. BURGESS: I wish to read a telegram which was sent by direction of the Association to Mr. H. E. Summers:

December 29, 1915.

To H. E. SUMMERS,
Albuquerque, New Mexico.

"American Association of Economic Entomologists sends hearty greetings and best wishes."

GLENN W. HERRICK, *President.*
A. F. BURGESS, *Secretary.*

PRESIDENT GLENN W. HERRICK: We should consider at this time the design to be used on the official seal of the Association.

On motion it was voted that the matter be referred to the executive committee who should select either a profile of Dr. Harris or a plain seal, with power to adopt and have the seal prepared for official use.

PRESIDENT GLENN W. HERRICK: The next on the program is fixing the time and place of the next meeting.

On motion it was voted that the next meeting be held at the same time and place as the meeting of the American Association for the Advancement of Science.

PRESIDENT GLENN W. HERRICK: I wish to take this opportunity to thank all for their coöperation in making this meeting a success and particularly the effective service of those who acted on committees. If there is no further business we will adjourn.

Adjournment 1.30 p. m.

PART II. PAPERS AND DISCUSSIONS

THE PRESIDENT'S ADDRESS

THE NEED OF A BROAD, LIBERAL TRAINING FOR AN ECONOMIC ENTOMOLOGIST

By GLENN W. HERRICK, *Ithaca, N. Y.*

"The worst weed in corn may be corn,"

"So a too exclusive study of entomology is the poorest kind of preparation for an entomologist."

We are fortunate individuals in many respects. We are fortunate in living in an era of almost incredible progress in our knowledge of the secrets of nature. The boldest imagination would hardly dare to predict regarding the advances and discoveries that may be made in the next ten years in the field of the natural sciences. No part of this field of knowledge has been entirely exempt from this general advance; and in no phase of the work has there been more amazing progress than in that of the applied science of entomology. It has advanced astonishingly in the number of persons engaged in the study of insects for the ultimate purpose of preventing their ravages; in developing and perfecting mixtures for repelling and killing them; in devising effective apparatus for applying insecticides; and in determining more exact methods of preventing the losses caused by these persistent pests.

We are also fortunate in being associated with a phase of scientific work that is in accord with the modern trend of ideas and with the demands of the age. That is, we are engaged in a practical, economic and applied phase of the science. We shall not have to shift our ground in this respect as some of the related sciences are being forced to do. For example, one of our most distinguished botanists has said, "It can scarcely be successfully denied that the most significant recent advances in American botany have been along economic lines. . . . It is scarcely to be supposed that economic botany is a passing fad and that pure botany, as we call it, will once again come into a place of dominance. The shifting emphasis in botany is but a part of a great movement as broad as humanity itself."

Others of the so-called pure sciences are feeling this pressure of the economic or applied influence and are slowly shifting their grounds. We, however, are already allied with a young and rapidly advancing science that, from its applied nature, is in accord with the tendency

of the present ideas and activities of humanity. We are, therefore, to be congratulated both on the splendid progress of our profession and on its harmonious relations to humanity. On the other hand, lest we become lulled into a sense of security regarding the state of our science, lest we become filled with a dangerous sense of complete satisfaction with our past and present achievements, and lest we magnify too much the desirability of a practical preparation for our work, I am going to take this opportunity of urging the need of a broad, thorough and rigid training for our future activities as economic entomologists.

It is well to realize that we are yet far from a satisfactory solution of many pressing entomological problems. A large part of the widespread interest shown in economic entomology at the present time is due not so much to the striking results already achieved as to the increasing demand for the accomplishment of greater things and the solution of new and more perplexing problems. Many of the simpler problems of our work have been fairly well solved. The more obvious and easy steps have been taken. We are now confronted with the more abstruse questions of insect control, the proper solution of which, calls for the highest sort of mental preparation, for the broadly trained type of mind—the mind that has been developed until it has become imaginative, until it is able to dream dreams. The speaker has not the time or space to defend the thesis that imagination is necessary even in an applied science. He will only ask if the men who invented the steam engine, the sewing machine, the telegraph, the telephone, or the monotype machine did not have minds replete with imagination. Yet these appliances are among the most practical in use today by the human race. There are big things in the field of economic entomology awaiting the minds that have become trained until they are able to see far ahead of mere facts—until they have attained the intuition of seers and the imagination of poets.

LeBaron in 1870 exercised a trained judgment and responded to the impulses of an imaginative mind when he recommended that an apple tree should be syringed with Paris green for canker worms; and what a remarkable suggestion it was and what a revolution it started in the control of insect pests in this country! Harris, a recluse among books, for he was a librarian most of his life, wrote a classic in American economic entomology. Nothing but his lively imagination and broad interests developed by a thorough training of the mind enabled him to accomplish so much under so many difficulties.

What a vision of the wonderful means of the multiplication of certain parasites and perhaps of their increased efficiency in the control of noxious insects was unfolded to us by Marchal's discovery of poly-

embryony! This brilliant piece of work was really the result of a most thorough, broad and extensive preparation on the part of Marchal, as an embryologist. The significant feature of the whole matter to me, is the fact that the training was doubtless acquired without the material thought in mind that it might produce results of a profound practical bearing on certain fundamental biological problems.

Sir Ronald Ross's successful search for the species of mosquito acting as a reservoir for the malarial germ sounds almost like a fairy story and as interesting as an Arabian Night's tale. Only a man of vivid imagination and of profound faith in himself and his judgment engendered by a broad and vigorous training could ever have persisted in the search and brought it to so brilliant a conclusion.

Not one of these discoveries or pieces of work was the result of accident or of haphazard experimenting. Each was the deliberate outcome of a broadly trained and imaginative mind. Each was the fruition of long and arduous study in wide fields of knowledge and each has marked an epoch in the history of economic entomology and its relation to the human race. What one of us younger men feels that he has prepared himself broadly enough, intensively enough, culturally enough, and imaginatively enough to contribute as large a share to the advancement of the science?

I have been greatly interested in reading again the papers on the teaching of entomology presented to this Association in 1911 by four of the pioneer teachers of this subject in the United States. Again, I have been profoundly impressed with the fact that all of them, each unknown to the other, greatly stressed the need of a broad, foundational training for successful work in economic entomology. It is well worth while to quote briefly from these papers. The first speaker says, "Thus early I gained a hint of the scope of entomology and was led to realize that the practical application of the science should be based upon a broad and accurate foundation of scientific knowledge." The second speaker says, "For the intending graduate student, therefore, I would urge a broad undergraduate course with plenty of chemistry, physics and botany but with sufficient attention paid to the cultural subjects and those connected with our duties, as citizens, to give breadth in every way, languages as tools aside from their cultural value should not be omitted." The third speaker emphasizes the desirability of a broad training in these words, "There is, therefore, the necessity that we should have trained investigators for the acquisition of further knowledge concerning insects, the discovery of which is one of the most important duties of modern entomology. For the purpose of this kind of instruction, it is absolutely necessary that there be thorough training in related sciences as well as in the general foun-

dation in other branches of knowledge." The last speaker requires his students to take work in zoölogy, botany, Latin, German, and French, not merely for their utility but also because of their cultural and broadening value. Thus we have in the foregoing brief quotations a forceful summary of the opinions of our older and more experienced teachers on this fundamental question. But let us consider this question in the light of recent developments.

Within the last two decades, applied entomology has shown such a marked and rapid trend in a certain direction that it demands our attention and careful consideration in connection with the theme of this discussion. I refer to its conspicuous tendency to come closer and closer to the vital activities of human beings. As a result of this trend, the economic entomologist suddenly finds himself drifting more and more into intimate relations with humanity. One has but to recall the fly and mosquito campaigns in many localities of our country; the work of Gorgas and his assistants in making the Panama Canal a possibility; the work of the physicians, Reed, and his associates on the field of Quemados and the entomological significance of that work; and the campaign against fleas in San Francisco to check the bubonic plague, to realize the force of the foregoing statement. Moreover, the work of the Horticultural Commission of California, practically an entomological quarantine board, in the seaports and counties of that state; the functions, rights and responsibilities of the Federal Horticultural Board; and the several state entomological quarantine regulations, all show how intimately the economic entomologist is dealing with the very life and economic forces of the people.

I have been profoundly impressed, while watching the westward march of the cotton boll-weevil, with the effect a single insect may exert on the economic life of a people. This insect has changed the agricultural thinking of the South and will ultimately bring about a marked change in the agricultural practice of the people in the infested territory. Affecting as it does the most important crop grown in the United States by virtue of its peculiar economic position, because cotton serves virtually as a means of exchange, and because it, beyond any other exported product in the United States, serves to settle our debts abroad, the weevil could not fail to affect vitally the economic welfare of the people; and any entomologist dealing with it becomes, by virtue of his profession, intimately associated with the welfare and very existence of his constituents.

I have also been keenly sensible of the influence of the malarial mosquitoes on the energy, efficiency, and accomplishment of a people. And the men now engaged in studying this problem will find themselves ingratiated into the lives of the people about them and will add to the prestige of our profession among the people of this country.

The economic entomologist is inevitably drifting more or less into the rôle of a leader in his community or state. The influence of his presence among the progressive farmers of his territory is bound to make itself felt. Leadership demands a true understanding of real, effective service to humanity and he who serves his fellowmen best and most lastingly, must be a man of wide, clear vision, liberal ideas, and large sympathies.

We are gratified with this growing position of the economic entomologist in the affairs of the people; but we must realize that it brings added and grave responsibilities which must be lived up to and met in exactly the same catholic spirit in which they come to us. To meet these duties in a large, sane, and efficient way, a man should possess sound judgment and wide knowledge of men and their affairs. We have been delighted and inspired by the fact that one of our older members has been recently honored as the leading citizen of his state. Not alone because of his purely entomological work but because his work was broad enough and sane enough to fit into the lives and activities of the people. It seems to me that the economic entomologist of the future must acquire a wide and thorough knowledge of the history and development of his country, of the characteristics, ideals, and aims of his people and of the economic forces governing their welfare.

Again, there are other phases of the more recent developments of economic entomology that emphasize the need of a thorough and liberal preparation. For example, the work in so-called medical entomology is calling for the highest type of broadly trained men. The discoveries of the direct relations of insects to man have opened up a tremendously vital field of work for the economic entomologist. The problems in this field that will present themselves in the future are sure to be complex and intricate and to be bound up closely with interrelated problems that will demand broad knowledge, trained judgment, profound insight, and the ability for the closest scrutiny and discrimination. No one who has not been trained to close, extended application, and who has not had the imagination developed, need expect to solve successfully the problems in this field.

There is another development or tendency arising in the botanical-zoölogical field that in order to be met and stemmed successfully will demand thoroughly trained men and a high type of work. I refer to the tendency to submerge economic entomology in the field of phytopathology. Doctor Howard has already pointed out the absurdity of this movement and the need of resisting it. One of the most successful means of preventing this tendency from being realized is for the economic entomologist to perform his work in such a broad, fundamental manner that it will be differentiated as a clear and dis-

tinct field from that of plant diseases. Fundamental, basic work of this kind demands a liberal and rigorous mental training.

Again, we hear a great deal these days about research but I am afraid that we do not grasp all that is being said concerning it. In fact, I sometimes wonder if the speakers themselves really understand all that they are saying on the subject. Of one thing, I am convinced. There is little use to talk of real research until genuine scholarship has been attained. The world is demanding research at a time, it seems to me, when we have somewhat fallen away from the rigorous methods of mental discipline of half a century or more ago. If we expect to discover basic facts and if we expect to justify the expenditure of the funds now being thrust upon us for research, we have got to reinstate a love for learning and a sincere desire for scholarship. We have got to foster and create scholars with an unquenchable thirst for the pursuit of the unknown and an ability to find it.

Not long ago, I had the opportunity of visiting certain intensely busy fields of economic entomological work in the southern part of the United States. During this trip, I saw two phases of work that greatly interested me and that left an impression on my mind that grows with the lapse of time. The two series of experiments dealt with the tropisms of two notorious insect pests—in one case with the chemotropism of a small beetle, in the other case, with the phototropism of a moth. I do not know that any satisfactory results in either case have yet been obtained. I do know, however, that these experiments are being made in a fundamental way and I feel that they are fraught with undreamed of possibilities in the way of insect control. It is neither appropriate nor desirable in this paper to discuss the tropisms of insects. What I desire to say is that here is a whole field, comparatively new, for the economic entomologists who are prepared to develop it. European entomologists are already entering the field. The work will demand thorough training in closely related sciences, intimate knowledge of foreign workers and their languages, a sane, well-balanced judgment that can correlate and interpret results, and a mind of imagination and vision that can see far ahead of mere facts. I look forward with great enthusiasm to the researches that are bound to be made in these fields when we develop men properly trained for the work.

This leads me to say a word regarding the desirability of every economic entomologist to have a knowledge of the history of his science. For a proper background of the science of applied entomology, one should have a fairly full knowledge of the history of the subject. Economic entomology, as a distinct field of endeavor, is comparatively young and a fairly complete knowledge of its rise and

progress can be rather easily obtained. The course of its development has been an interesting one and in many respects an inspiring one. The older workers, especially, have been men with whose lives we may very profitably become acquainted. I would earnestly urge every young man intending to follow applied entomology as a profession to become intimately acquainted with the lives of such men as Harris, Fitch, LeBaron, Walsh, Riley, Lintner, Fletcher and Saunders. I am convinced that a knowledge of the development of one's favorite science will act as an incentive and inspiration to fresh and extended endeavor. It will also aid in developing a worthy pride in adding something to what has already been done and will give a clearer view of what remains to be accomplished.

Lest I be misunderstood and lest some may fear that the speaker is overemphasizing the theoretical to the neglect of the practical side of an entomologist's training, allow me to say that elsewhere I have set down in detail what, it seems to me, would constitute an ideal course of study as preparation for applied entomological work. In that discussion I have admitted and emphasized the desirability of a certain amount of practical field work and have also noted its kind, its extent, and the place it might well occupy in such a course of preparation. The length of that discussion and the extent of what I desired to say in a more abstract way has precluded the possibility of including it here. I would like to say, however, in this connection, that there is a tendency among young men, especially undergraduates, to study only those things that they think are going to be of actual *use* to them in their future work. So many young men say to me that they do not want to take this or that course because it will be of no use to them in their profession as an economic entomologist.

It is probably true that the mere knowledge of the processes involved in the solution of an algebraic equation in quadratics, or the mere knowledge of the laws governing falling bodies or the Latin subjunctive may never be of actual practical *use* in checking the ravages of an insect pest. We must not expect to use everything we learn, neither ought we to learn only *those things we expect to be* directly useful. We do not study certain subjects with the expectation of using the formulas and equations on the field of battle with the codling moth. It is certainly true that we shall forget most of the facts we learn in college concerning mathematics, physics, Latin, chemistry, and kindred subjects; but not one of us will ever lose the broadness of view and culture of mind gained in acquiring this knowledge and not one of us will ever lose the benefit of mind training received from mastering these subjects. The significant fact, the fact that counts, is that the

mind has been trained and developed by close, accurate, rigorous thinking in several fields of knowledge.

But I hear some say that these are old, trite arguments. I admit it and agree that they are out of fashion; but I believe that these truths need to be resuscitated, revivified, and rehabilitated in the minds of the younger generation. I almost wish it were possible for a young man to go to college without having the thought foremost in his mind that he must fit himself to earn a living.

The modern cult of efficiency is misleading many young men into thinking that they must study only those things that make toward practical success in their chosen profession. We see Europe bathed in the blood of a mighty war because nations have as their highest ideals, apparently, the efficiency of their peoples in trade, in manufactures, in spreading over the earth and holding more land, in short, in performing greater material feats. Bailey has touched upon this question in a fine way when he speaks of the use of the land. He says, "It is urged that lands can be most economically administered in very large units and under corporate management; but the economic results are not the most important results to be secured, although at present they are the most stressed. The ultimate good in the use of the land is the development of the people. It may be better that more persons have contact with it than that it shall be executively more effectively administered." In other words, efficiency of administration, the securing of economic results may not be the most important objects in life. The development of men should be the highest aim of a system of education or of a government.

I plead for a broad, liberal training because I firmly believe that a course of study which demands logical, orderly rigorous thinking, consistently carried out over a period of several years during the growing and formative period of a young mind will contribute more toward making a faithful, honest, accurate observer and interpreter than any other form of intellectual training yet devised. I believe that a mental training of this character is one of the surest means of freeing the mind from prejudice, misconception and dogmatism.

I plead for a liberal intellectual training because it will widen one's perspective of life. The man who, especially during his younger, undergraduate days, is engrossed in one thing, who thinks of but one realm of nature, who deals with but one science, and who studies only one phase of the animate world is apt to become narrow and to lose understanding and appreciation of other lines of endeavor. More than that, he is liable to lose touch with the vital problems of life and humanity and fail to judge his problems in a large and adaptable manner. His very nearness to his work and his limited field of vision precludes the accomplishment of really vital things.

It is the lack of severe mental training; it is barely tasting the Pierian Spring, that breeds shallow thinking and superficial results. A scholar in his calmer moments, at least, as Milliken says, ought to "be a man who exemplifies in his whole life the very essence of temperance, a man who is always rational and consecutive in his thinking, just and truthful in his speech, dispassionate and fair in his analysis." The future work in applied entomology will demand, more than ever, scholarly men and these are to be obtained only through a course of broad training and rigorous thinking.

Finally, I would urge upon every teacher of entomology and upon every one interested in the success of our favorite science, the importance of emphasizing to young men, who contemplate choosing applied entomology as a field of labor, the desirability, nay, the necessity of a thorough and extensive preparation. Economic entomology will certainly play an increasingly important rôle during the coming years in the development of rural life. As our knowledge of the activities and habits of insects increases we realize more and more keenly the far-reaching effect these tiny but multitudinous animals may exert upon the basic welfare of all mankind. I am, therefore, profoundly impressed with the possibilities and the greatness of applied entomology as a profession and am greatly concerned with the need of young men being properly fitted for the work. Upon the young men now entering the profession will rest the responsibility of maintaining the fine reputation of the older workers, of adequately meeting the present problems, and of securely laying the foundations for the larger field of the future.

Reading of Papers

President Glenn W. Herrick: The first paper on the program will be given by Mr. J. W. McColloch.

A PRELIMINARY REPORT ON THE LIFE ECONOMY OF SOLENOPSIS MOLESTA SAY[1]

By J. W. McColloch and Wm. P. Hayes, *Assistant Entomologists, Kansas State Agricultural Experiment Station*

Introduction

In the spring of 1911, the Department of Entomology of the Kansas State Agricultural Experiment Station received several reports from southern Kansas of kafir seed being destroyed, soon after it was

[1] This paper embodies the results of some of the investigations undertaken by the authors in the prosecution of project No. 92—Investigations on the Staple Crop Insects of Southern Kansas—of the Kansas State Agricultural Experiment Station.

planted, by a small ant. Early in June, 1911, the senior author visited several fields where injury was reported and collected a large number of the ants, specimens of which were sent to Dr. W. M. Wheeler[1] who determined them as *Solenopsis molesta* Say. In investigating this injury it was found that several hundred acres of kafir had been destroyed and that many fields had been replanted three and four times. In 1912 and 1913 the reports of injury increased and it became evident that this pest was worthy of some investigational work. Accordingly, in 1914, a field experiment station was established at Winfield, Kansas, and the junior author placed in charge. This station has now been in operation two years and during that time considerable progress has been made toward a knowledge of this insect's life economy.

Classification and Synonomy

Solenopsis molesta belongs to the family Formicidæ, sub-family Myrmicinæ. It was originally described by Thomas Say in 1835 as *Myrmica molesta*. Dr. W. M. Wheeler has kindly furnished the following synonomy of this species:

Myrmica molesta Say, Boston Journ. Nat. Hist., 1, 1836, p. 293.
Myrmica exigua Buckley, Proc. Ent. Soc. Phila., 1866, p. 342.
Solenopsis debilis Mayr, Verhand. Zoöl. Bot. Ges. Wien. 36, 1886, p. 461.
Solenopsis molesta Emery, Zoöl. Jahrb. Abth. f. Syst., 8, 1894, p. 277.

There has been considerable confusion existing between *Solenopsis molesta* and the tiny house ant, *Monomorium pharaonis* Linn. Several writers considered Say's *Myrmica molesta* as a synonym of *Monomorium* and Mayr believed this to be the case when he described *Solenopsis debilis*. According to Doctor Wheeler, "Emery was the first to insist that this was merely a synonym of Say's *molesta*."

There are a number of references in the American literature to *Solenopsis fugax*, which is a European species. Doctor Wheeler in a recent letter says, "*Solenopsis fugax* is a European species and does not occur in this country. It is extremely close to *Solenopsis molesta*, however. Undoubtedly all references to *fugax* in American literature refer to *molesta*." For this reason the American references to *fugax* have been considered in this paper.

Distribution

Solenopsis molesta has a wide geographical distribution, being found over most of the eastern half of the United States.

[1] The writers desire to express their appreciation to Doctor Wheeler for determining the ants mentioned in this paper and for supplying the synonomy of *Solenopsis molesta*.

Say (1)[1] describes the species from specimens collected around Philadelphia. Fitch (2) records it in damaging numbers in New York as early as 1850. Mayr (7) described *Solenopsis debilis* from specimens taken in the District of Columbia, New Jersey, Virginia, Texas, and New York. Forbes (5, 13) reports it several times from Illinois. Wheeler (15) records it from the eastern and northern states, Texas, and as far south as Cuernavaca, Mexico. He also mentions finding a large nest on Naushon Island, Mass. Pierce (21), *et al*, found it in Oklahoma. Tanquary (23) records taking sex forms in flight at Boston, Mass. Gaige (25) found a single worker on a rock outcrop on Charity Island, Lake Huron.

This species appears to be well distributed over the eastern half of Kansas, specimens having been taken in twenty-two counties in the eastern part of the state.

History and Economic Importance

While there are many references to *Solenopsis molesta* preying on other insects and acting as a scavenger, it is primarily an injurious insect.

In describing this species, Say (1) states that this is the "little yellow ant" commonly found in houses and that it sometimes eats vegetable food and garden seeds.

According to Fitch (2), it is one of the worst ants infesting houses and fields in New York. It is very fond of saccharine substances and is commonly found feeding on sweetened foods, in the house. It is also found frequently in pastures and plowed fields and in 1850 it threatened the corn crop by gnawing the tender leaves.

Forbes (5, 6), in 1884, records *Solenopsis fugax* present in sorghum and broom corn fields, injuring the fruit of strawberries, and gnawing out seed corn. In 1894 (13), he reports *Solenopsis debilis* feeding on seed corn in the ground and kernels in the ear. He also observed this species attending the corn root aphis.

Webster (10, 11) in several papers describes this species as injuring strawberries, blackberries, seed corn, cured hams and ripe apples.

There are a number of references to this ant as a predaceous enemy of injurious insects. Brooks found *Solenopsis debilis* attacking the grape curculio (*Craponius inæqualis*) (16) and the walnut curculio (*Conotrachelus juglandis*) (18). Headlee and McColloch (22) often observed *Solenopsis molesta* carrying chinch bug eggs. Brooks and Blakeslee (26) found this species attacking codling moth larvæ.

In Kansas, the chief injury consists of destroying the seeds of kafir, cane, milo, and feterita shortly after they are planted. In a few cases

[1] Reference is made by number to "Literature Cited."

they have also been found injuring seed corn. Within a day or two after the seed is planted the ants attack it, hollowing out the kernel and generally preventing germination (Pl. 2, figs. 6 and 9). During the past four years thousands of acres of sorghum crops have had to be replanted from one to six times because of the ravages of this ant and in a number of cases it has been impossible to obtain a stand. With seed at $3.00 a bushel, as it was in 1914, this means a considerable money loss as well as time and labor spent in replanting.

Methods of Study

Considerable difficulty was encountered in finding a satisfactory method of rearing this ant under artificial conditions that would permit of daily examination. Because of the minute size of the workers, such cages as the Lubbock, Janet, and Fielde proved unsatisfactory. Finally, a modified type of the Janet cage was constructed, which, although not entirely satisfactory, proved useful. This cage (Pl. 2, fig. 8) is made by moulding a block of plaster of Paris in an ordinary dinner plate or saucer, having the upper surface level with the top of the dish. On one side a small cavity is cut away for a water chamber, which can vary in size according to the size of the cage. Opposite this an oblong chamber about one-eighth inch deep, two to three inches wide, and four to five inches long, is hollowed out and the half of it farthest from the water reservoir is painted black and covered over with a small square of glass. This gives a covered and an uncovered chamber. The former is covered with a small square of black cloth, making a very satisfactory dark chamber which can easily be uncovered to permit examination. The uncovered area is used for a food chamber, which readily permits of the removal of old or decayed food. To prevent escape of the ants the food chamber is completely surrounded by a barrier of vaseline, which must extend up and over the adjacent edge of the glass covering the dark chamber. An extra safeguard is had in placing a thin layer of vaseline around the dark chamber before the glass top is put on. This not only fills up any small crevices through which the ants could escape, but also prevents the glass cover from slipping out of place. By making the dark room near the edge of the dish, forms in the nest can easily be examined on the stage of a binocular.

This cage is not altogether satisfactory as the ants will sometimes burrow through the plaster of Paris into the bottom of the dish. Before ants become accustomed to the vaseline many are caught in it, especially the winged forms, but after a time they learn to avoid it.

Larger ants like *Cremastogaster lineolata* Say and *Iridomyrmex pruinosus* Roger were kept quite successfully in these cages.

When the cage difficulty was eliminated, other serious problems presented themselves. As yet no single individual has been followed through all stages of its life cycle. The immature forms cannot be kept under observation when piled upon each other in large colonies. When small colonies are started, the cannibalistic instinct of the ants becomes more noticeable and before a series of eggs will hatch, or a group of larvæ become full grown, they may be eaten by their supposed caretakers.

Life-History

Egg.—The eggs (Pl. 2, fig. 1) are pearly white with a bright luster which changes, just before hatching, to a clear, semi translucent color. They are elliptical in shape and about .25 mm. long. The eggs are covered with a viscid substance which enables them to adhere in packets for purposes of transportation by workers or to the surfaces where deposited.

Eggs are laid by the fertilized queens and cared for by the workers. Queens, when unattended by workers, will care for and carry packets of eggs from place to place in the nests. Unless eggs are attended by either workers or a queen, they will not hatch.

Fertilized queens collected in the field and placed in artificial nests cease egg laying almost entirely, and the few that are occasionally laid are soon greedily eaten by the workers. This condition, coupled with the fact that large numbers of eggs in a nest are hard to keep under observation, makes it difficult to determine the length of the incubation period. The methods used by Newell and Barber (24) on the Argentine ant were employed to work out the length of the egg stage. A fertile queen was placed in a nest with a small number of workers and assuming the time from the laying of the first egg to the time of the first one hatching to be the time required for incubation. This period was found to vary from 16 to 28 days, depending on temperature and moisture conditions. The daily egg-laying record of eight queens was taken for a period of 16 days by removing from the nest eggs laid during each day. The average number of eggs laid was 103.3. The greatest number from one individual was 387 and the smallest was 27. One queen deposited 105 eggs in a single day. Table I shows how the egg record of a queen will decrease after being put in an artificial nest. This queen was taken in a large colony May 10.

TABLE I. DAILY EGG RECORD OF A QUEEN

Date	No. Eggs Laid	Date	No. Eggs Laid
May 11	52	May 27	14
May 12	94	May 28	5
May 13	105	May 29	0
May 14	36	May 30	1
May 15	3	May 31	0
May 16	0	June 1	0
May 17	0	June 2	0
May 18	9	June 3	2
May 19	10	June 4	20
May 20	13	June 5	5
May 21	0	June 6	0
May 22	16	June 7	1
May 23		June 8	4
May 24	0	June 9	1
May 25	13	June 10	9
May 26	36	June 11	0

LARVA.—The larvæ (Pl. 2, fig. 2) of this species resemble superficially the larvæ of any other of the Myrmicine ants except, perhaps, in size. They are white in color and covered with double-hooked hairs which enable them to cohere in packets to be carried by workers. The posterior end is large and tapers toward the anterior end, which is considerably curved. This curvature becomes less pronounced as the larva grows older but is never entirely obliterated. Larvæ were frequently observed, while lying on their back, to straighten out their curved body by lifting their head and dropping it back onto the body. These movements are repeated at short intervals and the mandibles open at each up-movement and close on the down-movement. These moving larvæ were generally fed by workers at once, or soon after making these apparent supplications.

Larvæ are fed regurgitated food by the workers. Workers, in artificial nests, were often seen to place small bits of crushed kafir seed and torn parts of their own larvæ and pupæ on the body of the larvæ near the mouthparts where the larvæ were seen to bite them.

As the larva becomes full grown a large undigested meconium is voided from the alimentary tract. Workers were seen at times aiding the larva to get rid of this mass by tugging at it while it was being cast off. This change marks the end of larval development and the beginning of the semi-pupal stage.

The length of the larval stage is highly variable, depending on weather conditions. During midsummer larvæ were reared to the semi-pupal stage in 21 days, while others will live through the winter. A single larva was under observation from October 10 to May 12 when

1

2

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4

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8

9

1. Eggs; 2. Worker larvæ at different stages of growth; 3. Worker pupæ; 4. Workers; 5. Winged queen (♀); 6. Kafir seeds hollowed out by workers; 7. Comparative sizes of pupæ; queen (left), male (middle), worker (right), all enlarged; 8. Rearing cage used (dark chamber is uncovered), reduced; 9. Germinating kafir seeds hollowed out by workers, enlarged.

it transformed to the semi-pupal stage. The semi-pupal stage was found in midsummer to range from 2 to 11 days.

Large larvæ have often been encountered, in nests of this species, which were, undoubtedly, either larvæ of males or queens. None were ever reared successfully in artificial nests. Except for their much greater size, they seem to resemble the worker larvæ, and upon reaching their final stages of growth undergo similar changes.

PUPA.—The comparative sizes of the worker, queen, and male pupæ are shown in Plate 2, figure 7. The worker is the smallest, the male intermediate, and the queen the largest. The three forms are white during the early stages of pupal development, but as development proceeds they gradually assume the color of the adult form. The queen and worker pupæ become a pale yellow, almost as dark as the adult. The male changes to a dark brown before transformation.

The length of the worker pupal stage was found to be from 13 to 27 days. The same period for males and queens has not been determined. Worker pupæ, when ready to transform, are assisted in shedding their pupal skin by attendant workers. This skin is torn off in the form of a thread over the long axis of the body as one would unwind a skein of yarn. Pupæ are not enclosed in cocoons.

ADULT.—This species has but three kinds of adults, workers, males, and queens. There are no major and minor workers or soldiers. Workers, after emerging from the pupal stage, are very pale yellow in color and helpless. They are cared for by attendant ants which carry them about. In from two to three days these callows become thoroughly pigmented and are able to care for themselves. The worker (Pl. 2, fig. 4) is one of our smallest ants, being from 1.5 to 1.8 mm. long and is pale yellow in color. Vestigal eyes are present. The antennæ are ten-jointed. Spines are absent on the metathorax. The pedicle is two-jointed and the abdomen is armed with a sting. Say (1) in his original description says, "Their sting is like the puncture of a very fine needle." In two years' handling, the writers have never been stung by this ant. Workers constitute the greater part of the colonies.

The queen (Pl. 2, fig. 5) is of the same general yellow color as the workers with a darker (almost brownish) color on the head, prothorax, and between the dorsal abdominal segments. The prothorax is unarmed. Before fertilization, the queen has two pairs of hyaline wings which are lost after mating occurs. Antennæ are eleven-jointed.

Males are intermediate in size between the queens and workers. Their length varies from 3.5 to 3.6 mm. The legs and antennæ are

yellow, while the body color is a shining brown. The wings are hyaline. The antennæ have no club, as in the case of workers and queens, and the scape is also much shorter. The first funicular joint is enlarged to form the Johnstonian organ.

Habits

Locally, this species is known as the "kafir ant." Farmers whose crops have suffered from this pest know well the character of injury done, but seldom are acquainted with the depredator. This is, in part, due to their minute size and the hypogæic habits, although they are sometimes found on the surface of the soil.

The workers damage planted kafir seed in the same manner that has been reported by Forbes (13) for corn, who describes that injury as follows: "A kernel may be found wholly or partly hollowed out, the mealy interior being not devoured, but scattered about the earth, while the cuticle or outer shell of the seed remains but little disturbed." He is also of the opinion that the ants eat out the corn seed for the purpose of getting the oil. These attacks may occur before or after germination takes place, and in the case of kafir and other sorghums which they are known to damage, the seed apparently must be softened by moisture before they are attacked. Seeds that are injured after germination produce weak plants that soon perish. In southern Kansas, cane, milo, feterita, and maize also suffer to a more or less degree from the ravages of this pest. Workers have also been found feeding on windfall apples and plums, dead grasshoppers, larvæ, pupæ and adults of the maize bill-bug (*Sphenophorus maidis* Chittn.), larvæ of the corn-stalk borer (*Papaipema nitela* Gn.), larvæ of the Hessian fly (*Mayetiola destructor* Say), grasshopper eggs, pupæ of the corn ear-worm (*Chloridea obsoleta* Fabr.), and in 1905 they killed many larvæ of the white-marked Tussock moth (*Notolophus leucostigma* Smith & Abbot) in rearing cages at the Kansas Station.

The Colony

Nests are found in many different locations. Isolated nests are difficult to locate because of the small openings which are frequently some distance from the true nest. The colonies are numerous, but by far the easiest ones to locate are under rocks in pasture land. Nests have also been found in kafir, wheat, rye, oats, and alfalfa fields and are reported being in houses, but there are no records of this nature in Kansas.

Although isolated nests are frequently found in the open, or under rocks, this species seems to prefer building compound nests with other ants which they rob of their eggs, larvæ, and pupæ. It is not impossible, as is supposed in the case of *Solenopsis fugax* Lat., that these isolated nests of *molesta* may be connected with nests of other ants in the neighborhood by long underground galleries. It is by this hypogæic mode of travel that workers find and devastate fields of sorghum.

Isolated and compound nests are composed of small chambers whose walls are hardened and packed. They are connected by small galleries which, in compound nests, ramify through the workings of the colony of larger ants. The minuteness of these galleries prevents the larger ants from molesting the small invaders who forage with comparative safety.

Wheeler (15) reports *Solenopsis molesta* living in lestobiotic relationship with the following ants: *Pachycondyla harpax* Fabr., *Odontomachus clarus* Roger, *Camponotus fumidus* var. *festinatus* Buckley, *Camponotus maculatus* subsp. *sansabeanus*, *Formica sanguinea* subsp. *rubicunda* var. *subintegra* Emery, and different species of *Formica*, *Lasius*, *Stenamma*, and *Myrmica*. Forbes (17) records *Solenopsis molesta* living in harmony with *Lasius niger americanus* Emery.

In our work we have taken *molesta* in colonies of *Iridomyrmex pruinosus* Roger var. *analis* Andre, *Cremastogaster lineolata* var. *punctulata* Emery, *Ponera inexorata* Wheeler, *Pheidole* sp., and *Leucotermes lucifugus* Rossi.

In artificial nests *Solenopsis molesta* and *Cremastogaster lineolata* are decided enemies. The larger ants will bite and sting the smaller ants until they are exterminated but not, however, without a severe struggle in which the smaller ants bravely bite the legs and antennæ of the attacking giant. A compound colony of *Iridomyrmex pruinosus* and *molesta* was kept in an artificial nest without either being disturbed by the other. Each took up quarters in opposite sides of the nest.

In natural formicaries, winged males and queens appear in July. No data have been obtained on the mating flight. In artificial nests, queens were never fertilized. Tanquary (23) reports a mating flight in Boston as occurring September 5 at 5.00 p. m., and September 8. In artificial nests, queens unattended by workers will rear and care for the young. From this fact we can assume that, after fertilization, queens are able to establish new colonies without the aid of workers. In populous nests as many as nine fertile queens may be found. Table II gives the composition of a number of nests that have been examined.

TABLE II. COMPOSITION OF NEST

Date Collected	No. Workers	No. Pupæ	No. Semi-pupæ	No. Larvæ	No. Eggs	No. Queens (Winged)	No. Males (Winged)	No. of Larvæ and Pupæ of Sex Forms	No. Fertile Queens	No. Inquilines
April 16	149			31						20 mealy bugs
April 16	481			28						7 mealy bugs
April 19	1349			1902						
May 1	64		6	216						
May 10	535	324	456	662	1182				1	
May 29	*	*	*	*	*				9	
July 20	216	34		74	12	1				
July 28	336	247		78		4	2	73	1	1 mealy bug
Aug. 10	348	10		1						
Sept. 2	1436	2012	355	64	28					
Sept. 3	101	197		62						
Sept. 29	312	485		48						

* Not counted

Workers from widely separate colonies are antagonistic to each other when placed together. Queens were isolated from their workers for seven days and when put together were readily accepted by the workers.

No food has been found stored in the nest chambers of this species. In compound nests, the young of the consorting ant are always available and in isolated colonies final resource is made to their own young when a protein diet is necessary.

RELATION TO OTHER LIFE

Because of the lack of space the relationship of this species to other forms of life is represented graphically as an ecological complex by the accompanying chart. Previously reported facts are given a number referring to literature cited in the appended bibliography. Recent observations made by the writers are not numbered.

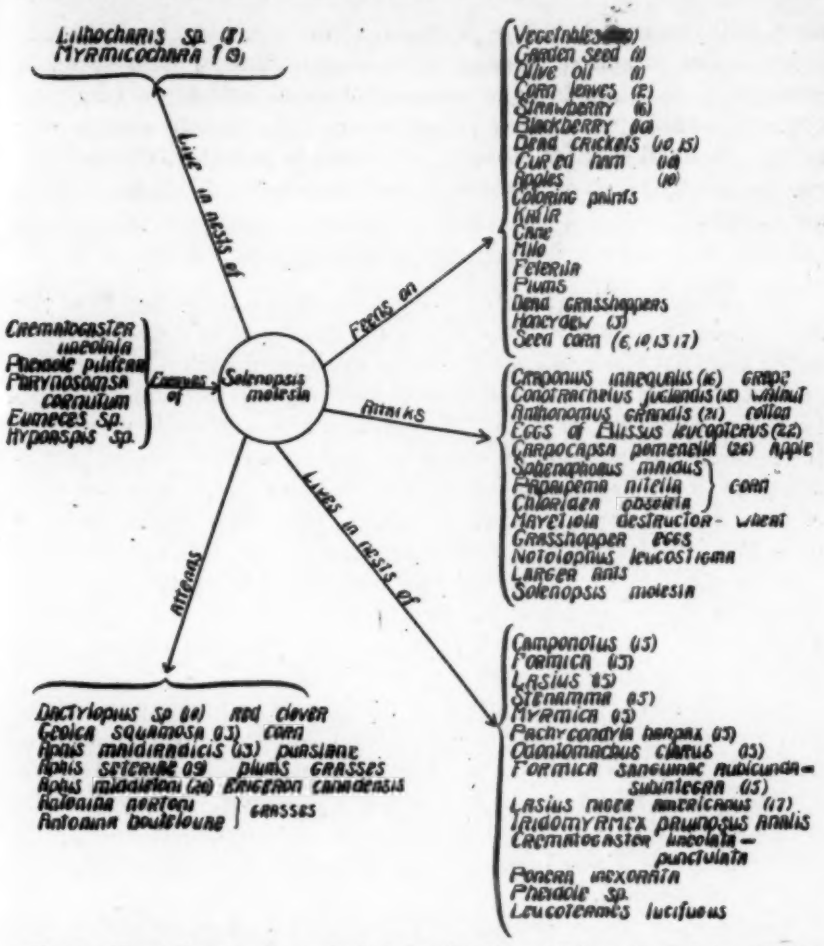

Fig. 1. Chart showing the ecological relationships of *Solenopsis molesta*. References to *Solenopsis debilis* and the American references to *Solenopsis fugax* are included. Numbers refer to bibliography and unnumbered references are original observations.

Natural Enemies

A glance at the list of injurious insects upon which this ant feeds shows us that, notwithstanding its injurious habits of destroying crops and in some places infesting houses, it is to be regarded as a beneficial predaceous insect, which is in turn preyed upon by other forms.

Spiders often trap the workers in their webs. Two other ants—*Cremastogaster lineolata* Say and soldier ants of *Pheidole pilifera* Roger—

were both observed killing workers. The common horned-toads (*Phrynosoma cornutum* Harlan), upon examination of their stomach contents, were found to have eaten numbers of *molesta* workers. In a single stomach of a skink (*Eumeces* sp.), one *molesta* worker was found. A small mite (*Hypoaspis* sp.)[1] which is probably ectoparasitic was repeatedly taken on workers, queens, and eggs. No endoparasites are known.

Methods of Control

The earlier investigations of this ant brought out the fact that the ants ceased to seriously injure the plants shortly after the seed germinated and that the measures of control must be of such a nature as to protect the seed between the time of planting and germination or to hasten germination, or both. A general study was made in 1912 of the agricultural methods practiced in planting sorghum crops, particularly as to the preparation of the seed bed and the manner and time of planting. A large number of farmers were interviewed, forty or more fields were examined, and many experiments were conducted.

From the data thus collected four methods of procedure were suggested for the protection of the seed between the time of planting and germination. These were fall plowing, early planting, surface planting, and treatment of the seed with some repellent.

Fall Plowing.—Fall plowing or listing aids in preventing ant injury by putting the ground in better condition for the germination of the seed. It allows the soil to accumulate more moisture and makes it much easier to prepare a seed bed in the spring. Every measure which tends to hasten germination reduces the amount of ant injury. This practice will also break up any nests of *Solenopsis molesta* that may be in the field.

Early Planting.—During 1911 and 1912, it was noticeable that all reports of injury were coming from late planted fields while the early planted fields showed practically no injury. Field investigations at this time, together with the general experience of the farmers consulted, brought out the fact that early planted seed was rarely if ever materially injured, especially if it was surface planted. In all the fields where injury was reported during these two years, it was found that the crop had been sown after May 20 and in many cases as late as June 1. The established time for planting kafir in southern Kansas, as determined by the Kansas Experiment Station and the United States Department of Agriculture, is about ten days after corn planting time or about May 10. It has been the custom throughout much of southern Kansas to put off kafir planting until the last thing.

[1] Determined by Nathan Banks.

SURFACE PLANTING.—Surface planting was first brought to our attention in 1911 on a farm near Hackney, Kansas. At this place twenty-five acres had been planted to kafir. Ten acres of this had been surface planted and the remainder listed. This field was examined June 7 and almost a perfect stand was found on the surface planted part of the field. The listed area had been planted three times and showed less than 50 per cent of a stand. The only explanation for the difference in stand was due to the method of planting. Further investigations have been made each year concerning this method of planting and the data thus far accumulated show that very little injury has occurred on surface planted fields, especially when the planting is made on or about the optimum time to plant kafir.

Surface planting has several advantages over listing and many of the experiments carried on in the area where the soil does not blow show that it is a little more preferable. Kafir seed needs a warm soil to germinate and unless the soil is warm it will lie in the soil many days giving the ants more time to work on it. It often happens in this case that the seed rots or decays if the soil remains cool too long. Surface planting provides a warmer seed bed and consequently greatly hastens germination. Kafir is often washed out or drowned out by heavy rains washing down the lister furrows or by standing in these furrows.

REPELLENTS.—One of the measures of control that early suggested itself was that of treating the seed with some repellent that would keep the ants away until the seed had germinated.

In 1912, the senior author conducted a number of experiments in the vicinity of Derby, Kansas, to determine the value of various repellents against the kafir ant. In one experiment ten plots of kafir were planted in a field badly infested with ants, using kerosene, turpentine, "Black Leaf 40," oil of lemon, camphor, refined carbolic acid, crude carbolic acid, and two brands of commercial chicken dip composed largely of crude carbolic acid and creosote. These plots were visited a week later and the results of this experiment are shown in Table III.

TABLE III. RESULTS OF DIPPING KAFIR SEED IN 1912

Treatment	Per Cent Germinated	Remarks
Dipped in kerosene	10	A few ants present.
Dipped in turpentine	10	A few ants present.
Dipped in "Black Leaf 40"	40	No ants present.
Dipped in oil of lemon	5	Ants numerous and in grains.
Dipped in camphor	5	Ants numerous and in grains.
Dipped in refined carbolic acid	0	No ants present.
Dipped in crude carbolic acid	87	No ants present.
Dipped in commercial chicken dip	92	No ants present.
Dipped in commercial chicken dip	91	No ants present.
Check	2	Ants very numerous.

The result of this experiment indicated that crude carbolic acid or any stock dip composed largely of crude carbolic acid and creosote would practically protect the seed. A number of farmers who had followed this experiment immediately began treating their seed with these substances and in every case they obtained an excellent stand.

The results of the work in 1912 were so promising that in 1913 crude carbolic acid and commercial dip, composed of carbolic acid and creosote, were recommended generally and many hundreds of acres were planted with treated seed. Many of the fields were visited later and in every case an excellent stand of kafir had been obtained. The lowest germination reported by any farmer was 75 per cent.

A continuation of the experiments in 1914 began to show many varying results. In many cases very few seeds would germinate when dipped in crude carbolic acid and in other cases the treated seed germinated as well or better than the check. Table IV gives the results of a number of germination experiments conducted during 1914.

TABLE IV. SHOWING EFFECT OF CRUDE CARBOLIC ACID ON GERMINATION OF SEED

Seed	Date	Per Cent of Germination		Check
		Dipped and Planted	Dipped and Dried 24 Hours	
Kafir	May 4, 1914	28		84
Kafir	May 22, 1914		23	32
Kafir	May 31, 1914	28	49	37
Kafir	May 31, 1914	28	36	69
Kafir	June 1, 1914	28		27
Kafir	June 8, 1914	19		41
Kafir	June 23, 1914	23		23
Kafir	July 11, 1914	7		3
Kafir	Jan. 26, 1915	25	4	15
Kafir	Jan. 26, 1915	31	10	33
Cane	May 22, 1914	35		48
Cane	June 1, 1914	35		29
Cane	June 10, 1914	19		38
Cane	June 23, 1914	12		7
Feterita	May 4, 1914	77		68
Feterita	May 22, 1914		62	92
Feterita	June 1, 1914	75		75
Feterita	June 10, 1914	33		76

In each case one hundred seeds were dipped in crude carbolic acid and either planted at once or allowed to dry for twenty-four hours. The results in this table are taken for a series of several hundred germination experiments and are typical of the results obtained. It is noticeable that there is a wide range in the per cents of germination in the treated seeds and that this is also true in the checks. There is

no doubt a number of factors which influence the variability in the rate of germination and the results thus far obtained indicate that this measure of control is still in an experimental stage and cannot always be relied upon. A study of the factors entering into this variability of germination indicates that the vitality of the seed has much to do with it. The seed used in the 1914 experiments came from the crop of 1913. The prolonged drouth of 1913 greatly reduced the vitality of the seed and it was difficult to obtain a high germinating quality. Mr. B. S. Wilson, of the Agronomy Department of the Kansas Experiment Station, stated to the writers that it was very difficult to obtain sorghum seed germinating as high as 80 per cent, most of the seed germinating much below this and some of it was as low as 4 per cent. A glance at the results obtained in the check plantings will show the low germination of the seed used. The year 1914 was also very dry and the quality of seed was but little better than 1913 so that it has been impossible to continue the germinating experiments further. A large number of other repellents have been tried and some promising results have been obtained. Kerosene and turpentine have been found somewhat effective in repelling the ants but only for a short time as the odor soon leaves the seed. "Black Leaf 40" has been tried in a large number of germination tests during the past two years and in no case has it injured the germination of the seed materially. Little data have been obtained as to its effect as a repellent but in a few cases where it was tried it has given favorable results. These experiments on the effect of repellents on the germination of the seed and the protection against *Solenopsis molesta* are being continued and it is hoped that more definite results can be given later.

SUMMARY OF MEASURES OF CONTROL.—From the data thus far accumulated the most practical measures of control against the kafir ant in southern Kansas are:

1. Fall plow the land.
2. Work the field thoroughly in the spring with a disk or harrow.
3. Surface plant the crop.
4. Plant early. This should be about May 10.

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President Glenn W. Herrick: We will now listen to a paper by Mr. M. P. Somes.

SOME INSECTS OF SOLANUM CAROLINENSE L., AND THEIR ECONOMIC RELATIONS

By M. P. Somes

Solanum carolinense L., or, as it is commonly called, "horse nettle," is among the most common weeds of Missouri, as also through a large part of the United States. It is in close botanical relationship with a large number of cultivated plants as tomato, potato, peppers, and tobacco. It is congeneric with *Solanum rostratum* Dunal, the Buffalo bur, from which we have, by transfer of food plant, one of our most serious pests of potato, *Leptinotarsa decimlineata* Say.

During our field studies we noted a series of very interesting insects on the horse nettle. Recalling the natural transfer, mentioned above, from an insect beneficial to man feeding on and destroying a noxious weed, to a serious pest feeding on an important cultivated plant, we were led to test transfers of certain of these insects. The dividing line between beneficial and injurious insects is determined by man's interpretation of the insect's activities. A large number of insects are feeders on varied plants, sometimes even in different families, so that a form of injurious status in one locality may possibly be reckoned as beneficial in another. During the summer of 1914, I noted a natural transfer of this sort which resulted in a harmless species suddenly developing into a pest inflicting serious injury to tomato. This was in the case of *Jalysus spinosus* Say, a common and widely distributed Berytid bug, heretofore considered as of no economic importance. The data concerning this bug have already been published (Mo. State Fruit Exper. Station, Bul. 24, pp. 16–17) but may be briefly summarized here. In July, 1914, a lady living near St. Louis wrote me that her tomatoes were being seriously injured by what she surmised was a mosquito. Visiting her place, I found numerous specimens of this slender, mosquito-looking bug. The injury is due to the puncturing of the fruit stems and the ovaries of the flowers, the common result being that the stems die beyond the puncture and the flowers when injured soon blacken and die. We have noted this injury at various times but thought it due to some form of tomato blight. In the California *Monthly Bulletin* for July 1914 the following note occurs: "At this season of the year many tomatoes fail to set fruit. Vines blossom well and appear thrifty. However, the blossoms, after hanging on the vines for a time, fall off, leaving a part of the peduncles attached to the stem. The cause is a fungus which causes late blight of potato and fruit spot of tomato." This description is exactly typical of the in-

juries resulting from the work of *Jalysus spinosus* and, venturing a guess, we would expect to find that at least a part of the injury is really due to the work of some Berytid bug. During the past two years this insect has worked widely through Missouri and in some districts, where tomato-raising for canneries is of importance, has occasioned serious loss. There are from three to four broods a season in Missouri and the adults pass the winter hibernating beneath leaves and other waste. The adults in feeding assume a most peculiar position of the beak which we have been unable to explain. The first joint is carefully worked into the tissues, then the basal joint is bent backward at an angle of nearly 45 degrees, the second extending horizontally to join the two outer joints at a wide angle. Despite this position which appears but poorly adapted for suction the insect feeds this way for long periods.

Sesia rileyana Dry.

Early in August, 1914, large numbers of the adults of this beautiful little clear-winged moth were found on *Solanum carolinense*. Specimens were sent in to the Division of Entomology at Washington for determination, when Dr. Howard wrote that the life-history was unknown. Hence in spring search for the larvæ revealed them in the stem of this weed and when found May 24 they were in about the third instar. The adults are slender-bodied, clear-winged moths, with the front wings very slender and rather broadly margined with fuliginous and with a red bar at the disk. Palpi and ventral portions of thorax are yellow while the thorax above is shining black. The abdomen is black with six narrow yellow transverse bands. Legs yellow save at the knees where they are brownish. The larva is subcylindric, sparsely pubescent, and rather similar though smaller than that of the common peach tree borer, *Sanninoidea exitiosa* Say. It bores in the central part of the stem, working downward to the roots and passing down one of the main branches at about the time it matures, bores out of the root into the soil. The pupa is formed in the soil, sometimes at a distance of three inches from the stem. The pupa itself resembles that of *Sanninoidea exitiosa* but instead of being surrounded by a gummy cocoon of chips and frass as with that insect, it is enclosed in a slender silken tube from one and a half to over two inches in length. The great mass of the moths emerge from the middle of August to about the middle of September. Our data as to wintering is as yet unsolved. For two years we have noted the mass emergence in August and September as mentioned, yet this summer we took scattered specimens of adults on June 30, July 1, 19, and 28. The specimen taken July 19 was placed in a cage with a growing plant of the

horse nettle and promptly began oviposition. The female clings to the petiole of a leaf with the abdomen touching the main stem. The slender and transparent ovipositor is extruded and the eggs are deposited singly or in groups on the stem. The eggs are oblong ovate, the upper surface broadly concave and the surface hexagonally ridged, the ridges fainter on the concavity. The color at first is nearly white, changing rapidly to a smoky black, the ventral surface remaining lighter. From these scattered adults throughout the summer we must assume a very irregular breeding period. In some of our experiments early in September, several plants of the horse nettle were taken up, together with squares of soil averaging about ten inches across. These were then placed in cages and watched for emergences. In a couple of days a male moth emerged from one of these squares. This was placed in another cage with a newly emerged female. Within fifteen minutes the pair were united, facing in opposite direction and remained in copulation for about an hour. Later examination of the plant in this cage revealed a total of 63 eggs attached to the stem and under side of leaves.

Transfers to Tomato and Potato.—To test the behavior of larvæ on other plants related to *Solanum carolinense*, we introduced them on the stems of tomato, potato, *Physalis pubescens* L. and *Solanum nigrum* L. The transfers were made by taking larvæ from stems of the horse nettle in June and placing them on stems of the desired host plant at places which had been slit or punctured. In every case they showed not the slightest hesitation, but promptly went to work and were soon out of sight. One little fellow, which was not carefully placed, fell off to the soil below where he was noted wandering aimlessly about twelve hours later but when placed in position again, he had worked his way into the tissues within three hours. Varying numbers, from two to six larvæ, were introduced into a single stem but in no case where the stems were spilt and examined in late August were more than two larvæ found alive. The growth in both potato and tomato and Physalis was perfectly normal and larvæ taken from these in August were vigorous and healthy and comparable in size with those taken from field plants of the horse nettle. In the case of Black Nightshade, *Solanum nigrum* L., however, every larva had died and in most cases before it had bored over an inch. In tomato and potato some borings were over eighteen inches long.

Climatic Experiments.—Noting the superabundance of adults in the fall of 1914, after a season of exceptional drought, we arranged a series of cages to give a rough test as to the effect of seasonal conditions on the growth of the larvæ. The cages used were of galvanized iron, 16 by 16 by 20 inches. Those of Series A were open-screen cages of the

ordinary type and well open to air. The plants and soil in these was kept well moistened during the whole period and the plants made fine growth and excellent color. The cages of Series B were similar to the first but with glass sides and top. In each were suspended two light porous cylinders filled with lime chloride. These cylinders were frequently removed and dried. Moisture was supplied to the plants in these cages by a sort of subsoil irrigation system devised as follows: The upper two inches was of ordinary compact soil, below this was two inches of sand and below this a mixture of soil and sand. From the sand layer, or aquifer, a one-half-inch tube extended up one side of the cage through which water could be supplied to the roots. Every effort was made to simulate the conditions of a drought. The growth of the plants in these cages, while fairly good, was not so vigorous or so deep in coloration as in Series A. Examination of the stems of plants thus grown led to the conclusion that the borers thrive best under conditions of drought. This was fully borne out by field records for the past two years. The fall brood of 1915, after a season of exceptional rainfall, was notably smaller than that of 1914, after a season of exceptional drought.

Cassida pallidula Boh.

Among the other interesting insects noted commonly on *Solanum carolinense* L. was this beautiful pale green, deeply pitted tortoise beetle. The larva is of the type common in the group, with its curious anal forks bearing an umbrella of excrement above its back. Larvæ were abundant on wild plants of the horse nettle and on June 30 a number were placed on both tomato and potato in separate cages. They began feeding at once and on July 9 pupation occurred, the adults emerging on the 14th. On July 15 copulation was observed on tomato and on the 17th eggs were found on the plants in this cage, while on the 19th eggs were also found on potato. The eggs are subcylindric, slightly flattened ventrally and with rounded ends and are enclosed in transparent sheaths. They are green in color at first, soon changing to brown. The eggs hatched in from 9 to 13 days and the larval period of the second brood was about one month. The pupation period was from 6 to 10 days.

Gargarphia solani Heid.

Another abundant and interesting insect on the horse nettle was this Tingitid bug, which, unknown to us at the time, had been recently discussed by David E. Fink in U. S. D. A. Bul. 239, where it is called the "Egg Plant Lace Bug." Since our data has been largely anticipated by this paper we will touch but briefly upon this insect. Specimens were transferred to both tomato and potato in separate cages

and watched there as also on horse nettle. The leaves soon showed innumerable black spots marking the feeding punctures, and, in the cases of tomato and horse nettle, soon turned yellow. Egg clusters noted on the plants hatched in from 8 to 9 days. Fink reports that his averaged 6 days but the difference is doubtless due to the fact that last summer was cooler than the summer of 1914 when his studies were made. For more complete data on this insect I would refer any one interested to the bulletin above mentioned.

The species listed above, though feeding and breeding on this very common weed, have been successfully transferred to both tomato and potato and have made good growth on both of these economic plants. If entomological prognostications are in order at this time it is probable that we may look upon these insects as possible pests on one or both of these plants under favorable conditions.

Trichobaris trinotata Say

This well-known pest is far more abundant in Missouri on *Solanum carolinense* L. than on potato and its larva boring in the stems may, at least in the earlier stages, be confused with that of *Sesia rileyana*, but is legless, shorter and more pointed at both ends. Transfers of these larvæ to potato were naturally successful but in tomato, also, when transferred from the horse nettle it was equally at home and entered in a perfectly normal manner, completed its maturation, plugged the boring both above and below itself with sawdust and frass, pupated and transformed to the adult within the boring. The beetles emerged late in September and *remain* in the boring, evidently to pass the winter there in hibernation.

In most texts the statement is made that the eggs of this weevil are laid at or near the surface of the ground but in all our many cages as well as in all our field observations, the eggs were placed in shallow holes gouged out in the axils of the upper leaves or branches and the larvæ gradually worked downward to the base of the stem for transformation.

Epitrix fuscula Crotch and *E. cucumeris* Harr.

Both of these flea beetles were noted abundantly on horse nettle as also on both tomato and potato, readily transferring their affections from plant to plant without any of our assistance. While our studies on these are far from complete yet we have data which indicates at least three broods per season in Missouri.

Phlegethontius carolina Linn. and *P. quinquemaculata* Haw.

These two common Sphingids were both taken on the weed under study and were readily transferred to both tomato and potato. When

we transferred *P. carolina* from horse nettle to tomato they unanimously changed from green to black at the first moult and we felt quite satisfied that this change was due to the change of food but just at that time we happened to bring in the same species from our tobacco and placed them on growing tobacco in our cages, when they just as promptly and just as unanimously moulted to black.

Another insect which we took on several occasions from this weed was a very peculiar elongate Lygæid bug, *Ischnodemus fallicus* Say, this with two leaf-rollers are still under study. One of the leaf-rollers transferred to tomato passed through its maturation and is now in pupa.

PRESIDENT GLENN W. HERRICK: I would like to ask Mr. Somes if these insects were found living on these weeds.

MR. M. P. SOMES: The study is based on twelve or fifteen insects found on this weed and was undertaken because of its close botanical relationship to so many important cultivated plants.

PRESIDENT GLENN W. HERRICK: It seems to me that studies of this kind are very important and that more information on our common native weeds might be very useful. The next paper will be read by Miss Edith M. Patch.

CONCERNING PROBLEMS IN APHID ECOLOGY[1]

By EDITH M. PATCH

It is apparent enough that in ecological work with an aphid, the fact of first importance to be ascertained is whether a given species is migratory, for, if it have two types of host plants, the problems that concern its life cycle are doubled, though the economic situation may be simplified by virtue of a greater choice in methods of control.

Something of the import of this was recognized by Walker, who, in 1848,[2] published "Remarks on the Migrations of Aphides," in which he records the alternation of food plants of several species with certain economic suggestions. This discussion included the migration of the hop aphid from the plum, *Siphocoryne capreæ* alternating between the willow and umbelliferous plants and a few other leaf-feeding species—the change in food plants not in any case involving any startling change in the habits of the insects concerned.

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[1] Papers from the Maine Agricultural Experiment Station: Entomology No. 84.

[2] 1848. The Annals and Magazine of Natural History, Vol. I. Second Series, pp. 372–373.

It remained for Lichtenstein to announce in various publications during the year 1877 his belief that European species inhabiting elm and poplar migrated to the roots of grasses.

Riley (1879[1]) took him vigorously to task for what he called Lichtenstein's "theory" explaining patiently that

> Species of the same genus often so closely resemble each other that they are more readily distinguished by their mode of life, or by the galls they produce, than by structural or describable differences; and this holds particularly true of the immature or apterous stages. This fact, taken in connection with what is here recorded and what is already known of the habits of the sub-family, renders it extremely improbable that any of the species subsist at one time on one plant and habitually change, by migration, to another of a totally different nature.

However, two years later we find Riley writing (1881)[2]:

> M. Lichtenstein has for some years fully believed that most of our Aphids, and especially the gall-making *Pemphigini*, habitually migrate, in the winged, parthenogenic, female form, from one plant to another, and that the species must necessarily inhabit two different plants before it passes through its full cycle of development. That it is the rule for most of the insects of this family to so migrate is evident from the fact, patent to all who have observed them, that there is a period in mid-summer when most of the species abandon the plants which they so seriously affect in spring and early summer. . . . The fact of migration rests, moreover, on repeated direct observations, and all spring gall-inhabiting species have usually vacated their galls by mid-summer. . . . In fact it is now coming to be well understood, that in this family the habit of the same species in spring is quite different to its habit in the fall, and that in the study of the insects of this family there is opened up to us a new and interesting field for observation. . . . We have for some time since recognized this fact of migration, but have been led to believe from the known facts in the case that the migration was necessarily from one plant to another of the same *genus*. M. Lichtenstein, on the contrary, believes that the change is still more wonderful and that many tree-inhabiting and gall-making species actually have a mid-summer life on the roots of grasses and herbaceous plants. He has recently communicated to us some discoveries that certainly justify his views.

The pioneer work in America in this "new and interesting field for observation" appeared in 1889[3] with the announcement of the identity of *Schizoneura panicola* Thomas and *S. corni* Fab., followed in 1890[4] by a fuller account with details of observations and experimental data showing that *S. panicola* is merely the grass-root form of the ancient Cornus aphid. In this synonomy was included *S. venusta*

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[1] 1879. Bulletin U. S. Geological Survey. Vol. V, No. 1. Biological Notes on the Pemphiginæ, with descriptions of new species.

[2] 1881. The American Naturalist, Vol. XV, pp. 819–820. Migrations of plant-lice from one plant to another.

[3] 1889. Insect Life, Vol. II, pp. 108-9.

[4] 1890. U. S. Dept. of Agri., Div. of Ent., Bul. No. 22, pp. 32–41. The grass-root plant-louse alias the dogwood plant-louse.

Passerini, under which name it had been described from the roots of grass in Europe.

It no doubt took some courage to announce that the well-known dogwood aphid of Europe was the same insect as an equally well known American aphid feeding on grass roots. It is not unlikely that this discovery came with something the same shock to the investigator that the identity of Dr. Jekyll and Mr. Hyde proved to people who had known "both" these men. There was something incredible about such a situation and a touch of timidity here and there in the paper indicates the realization that the problem was a serious matter and that the announced identity of three well-known aphids must not only rest upon facts carefully investigated, but that the data must be published with detail enough to carry the weight of conviction. There was also something humorous about it all. The grass aphids were rascals leading a dual life and at last brought to the bar of justice as is indicated by the title "The grass-root plant-louse alias the dogwood plant-louse."

This piece of detective work, the first of its kind in America, coming as it did when this type of life cycle had not long been recognized as a possibility for the plant-lice, and presented in a manner to put the reader in as nearly first-hand connection with the facts as possible, merits a place in the first rank of aphid investigations of this country.

Perhaps one of the most interesting things about the publication is the way it has been received by American entomologists. In 1894[1] appeared the following guarded statement concerning *Schizoneura panicola*: "This root louse has been identified . . . as an alternate form with a species of the same genus, *S. corni* Fabr., from the leaves of the dogwood (U. S. Department of Agriculture, Division of Entomology, Bull. No. 22, p. 40); but from all available evidence I am not yet satisfied that the species here described as *S. panicola* ever leaves the ground except to fly from the roots of one food plant to those of another."

In 1910[2] a second entomologist wrote of *S. panicola:* "Common on roots of *Panicum*. . . . It has still to be proven that this is identical with *S. corni*."

And in 1915[3] under the caption of *Anœcia corni* Fabricius, a third writes: "The lice completely desert the dogwood early in the summer and go to unknown plants."

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[1] 1894. 18 Rept. St. Ent. Ill., pp. 85–93. The Grass-Root Louse.

[2] 1910. Journal of Ec. Ent., Vol. 3, p. 413. List of the Aphididæ of Illinois, with notes on some of the species.

[3] 1915. Journal of Ec. Ent., Vol. 8, p. 100. Notes on some Colorado Aphids having alternate food habits.

It might be said that due recognition of this work identifying *Schizoneura corni* of dogwood and *S. venusta* of grass roots has been given in European literature (Mordwilko, 1907[1]) and the observations verified exemplifying the adage concerning the prophet and his own country.

However, it is neither in defence of the investigation of 1889 (for it can stand on its own merits) nor in criticism of the sceptical attitude of some of our foremost entomologists on aphid matters (for I realize that there is reason enough for caution), that I have devoted so much space to the case of *corni*. It is introduced into this discussion because it illustrates two phases of a problem with migratory aphids—that is the initial difficulty of the investigator in getting at the facts and the secondary difficulty of other people in accepting them.

Considering the complexities involved, neither difficulty is to be wondered at. Take *tessellata*, the common woolly aphid of the alder, for instance, with its continuous presence during the summer in the form of apterous females and during the winter as hibernating nymphs upon the single food plant—what place has it in its life cycle for a spring and fall migration from and to the maple? It was incredible that the maple leaf *Pemphigus* had anything to do with a species having an all year existence on alder. I watched that situation for four years before I dared publish it, but by that time I was not much disturbed when a kindly entomologist wrote me a friendly letter to explain that I had made a mistake, giving perfectly logical reasons to show that *P. acerifolii* simply had to be a species distinct from *P. tessellata* of the alder. There was absolutely nothing the matter with his logic—but it didn't stop the maple migrations of *P. tessellata*—at least in Maine.

Logically, the most absurd aphid case yet come to light is that of *Schizoneura lanigera*. Why, any entomologist could sit down and write a book of reasons explaining why the woolly aphid of the apple could have nothing to do with the elm leaf rosette. In the face of these reasons I must confess to something akin to a nervous chill when I first made sure that this common apple pest, with its perennially unbroken residence upon apple roots in the form of apterous females and its hibernating nymphs protected about the same tree, possesses a third normal and annual over-wintering form—that is the egg in the crevices of the elm bark from which hatches in the spring the stem mother of *S. lanigera*, the rosette aphid of the elm—the grandmother of the spring migrants to the apple. However, in spite of my own fright (and possibly that of other entomologists as well?), the migrants

[1] 1907. Biologische Centralblatt, XXVII Bd., No. 23. Beiträge zur Biologie der Pflanzenläuse, Aphididæ Passerini, p. 787.

from the elm rosette continue to settle upon apple and their progeny continue to have the characters of *S. lanigera*—at least in Maine. It is going to be interesting, by the way, to see how this species squares itself with that type of life cycle in certain localities. In Europe, for instance, even where the "woolly aphid of the apple" is troublesome, we have no published record of the rosette aphid of the elm. How does it get along there? Sustains itself by continuous parthenogenetic generations? At any rate it has not lost its habit of fall migrations according to the reports of Börner[1] and Reh.[2] Is it possible that it exists on the European elm but less conspicuously than on the American?

But why should it not be a simple matter—the mere finding out whether a species is migratory? Partly because every aphid cycle we learn is as likely to mislead as to guide us with the next species we investigate. We are in the habit of saying, for instance, that we know that *Aphis pomi*, *Myzus cerasi*, and *Schizoneura rileyi* do not migrate because they occur at all times of the year upon a single food plant, respectively the apple, the cherry, and the elm. That in itself is no reason for surety, for *Prociphilus tessellata*, *P. venafuscus*, and *Schizoneura lanigera* each occurs at all times of the year upon a single food plant, respectively the alder, the balsam fir, and the apple, and yet these are all migratory aphids. There is this distinction between these two cases, however, the three species first mentioned occur at all times of the year upon their *primary* food plant and the second three do not—with them it is their *secondary* food plant which harbors them for twelve months of the year in addition to their winter and spring residence upon their primary host. By "primary host" is understood that plant upon which the over-wintering egg is normally deposited and upon which the stem mother and her immediate progeny develop. The "secondary host" is that plant to which the spring migrants fly and from which they return to the primary host. At present I know of no member of the Subfamily *Aphidinæ* which resides for twelve months upon its primary host and in addition migrates for a part of the year to a secondary host. But it would be a rash person who felt safe in the conviction that such a cycle could not be.

Many migratory aphids, to be sure, alternate their primary and secondary host plants at regular intervals, each time entirely deserting the one for the other, thus existing for a part of the year only upon each. *Rhopalosiphum nymphaeae* Linn is an example of such a

[1] 1909. Die Blutlausplage und ihre Bekämpfung. Kaiserliche Biologische Anstalt für Land- und Forstwirtschaft. Flugblatt Nr. 33, p. 2.

[2] 1913. Neues von der Blutlaus. Der praktische Ratgeber im Obst- und Gartenbau. Nr. 5, p. 44.

cycle with its winter and spring habitation on the plum and its summer residence upon various water plants.

Aside from the idiosyncrasies of the aphids as regards their life cycles, their careers are difficult to follow on account of their elusiveness. A species needs to be *very* abundant, indeed, in order to give a field demonstration of its migratory actions. During ordinary seasons it is like looking for a needle in a haystack to obtain field data, even when you know what vegetation to watch.

And the difficulties are not by any means eliminated by bringing the material into the laboratory. Aphids are exacting—they must have succulent food plants with a good supply of sap or a "hunger strike" ensues which means death to the colony and very likely an indefinite postponement of the solution of the problem. Migratory tests ought to be proved out on plants grown from the seed to be absolutely sure of clean stock. Where this is impossible, the test plant should be brought into the greenhouse at least several weeks before migration begins, for two reasons: To secure uninfested material, and to give it an opportunity to get well rooted and ready for growth. It is not an easy matter to grow indoors some of the most common weeds under control conditions satisfactory to the demands of the experiment. I have had repeated failures (and but one success) trying to establish *cardui* migrants from plum upon thistle apparently only because I have not mastered the art of growing a healthy thistle under an aphid cage.

Even aside from the question of the health of the plant, there seems often to be an individual immunity of certain plants against aphid attacks. It is no uncommon thing to find one Norway spruce free from galls of *Chermes abietis* although its branches may touch a second Norway spruce heavily laden with these growths. One spring I stocked about sixty apple seedlings with *lanigera* migrants from elm rosettes and vigorous colonies were secured on but two of them.

Again different species vary exceedingly as to the behavior of their migrants. Some species, it is true, will plunge their beaks into the proffered food plant within a few hours and begin to establish their colony of young the first day and all is placid and straightforward. Other migrants, when removed from their primary host, will rest for a day or two or even longer quietly upon the leaves of anything that is offered them, and then suddenly, when the hour for flight has arrived, they take to their wings and fly as energetically away from their proper food plant as toward it, for it is their instinct to fly, and fly they must before they settle. Others are manageable when handled in small numbers and will settle quietly under such circumstances when they become excited if introduced into a cage in large numbers, and

desert their proper secondary host, evidently instinctively trying to find vegetation at a distance from their sister migrants where their progeny will not lack for ample supplies. Others, which may be too restless to work with in bright daylight, become docile at dusk.

For these and many other reasons it becomes evident that a failure with a migration test gives no data.

If an investigator fails in one hundred attempts to colonize thistle with migrants from plum that will not be a safe reason for him to conclude that he is not working with *Aphis cardui*, or that this thistle aphid has nothing to do with the leaf deformations of the plum in the spring. It has been my own experience that negative data with aphids under such conditions are just no data at all. If the structural characters are such as warrant the migration test in the first place, they warrant a patient continuation even in the face of repeated failures.

On the other hand (and this is the most encouraging and stimulating circumstance in connection with aphid migration tests), a single success goes a long way to prove the case. Barring complications, a single success is enough, and repetitions and verifications are needed only as safeguards in that respect. For these insects are remarkably stable as to their exclusive tastes in vegetable juices and a given species will die before it will submit to the sap of any plant not on its approved dietary. So if the progeny of the migrants accept the food plants given them in the laboratory to the extent of developing upon it from the first instar to maturity, it is safe to conclude that that food plant is one which they would accept in the field under favorable conditions, even though, with the wider choice of the open, a different one might be given preference in certain localities. Such proof should rest with the behavior of the progeny of the migrants and not with the migrants themselves, for the migrants, as has been suggested, have many ways of tantalizing the hopeful investigator.

Since the real proof of the validity of a tested food plant rests with the ability of the progeny of the migrants to develop upon it, it is much simpler to work with the spring migrants than the fall, return forms when dealing with the Pemphigini for the reason that it is easier to be sure that the immediate progeny of *Pemphigus bursarius*, for example, are developing upon the roots of lettuce than it would be to be sure that the stem mothers causing *bursarius* galls in the spring are hatched from eggs deposited by the progeny of the return migrants from lettuce the fall before. Aside from the fact that there are likely to be fewer complications with the spring forms, with many species it is often easier to locate and obtain abundant material in the spring.

But after all there is no set of rules for migration tests with aphids. It is perhaps only a matter of time and patience. The present national policy of watchful waiting applies as appropriately to the small affairs of the aphid as to larger matters.

PRESIDENT GLENN W. HERRICK: We will now listen to a paper by Mr. R. D. Whitmarsh.

LIFE-HISTORY NOTES ON APATETICUS CYNICUS AND MACULIVENTRIS

By R. D. WHITMARSH

Apateticus cynicus Say

This is one of our largest and most common predaceous, brown stink bugs. Unlike its near relative *Apateticus maculiventris*, it is but single-brooded. These bugs deposit but a single egg mass, according to my records, which consists, as a rule, of about forty-five eggs. The eggs are laid in late fall and the young emerge from these eggs anywhere from the middle of April to the middle of May, depending on the season. The eggs are of a reddish-brown color, barrel-shaped, and measure about one-tenth of an inch in height by one-sixteenth of an inch across. Like other pentatomid eggs, they are provided with a lid-like cap around which are about twenty short, club-like processes. At the time of hatching this lid lifts and a light reddish colored insect emerges which soon becomes dark red with black head and thorax and black spots along the dorsal portion of the abdomen. The length of time spent in the different instars depends greatly on the amount of food which the bugs are able to find. Under favorable conditions they will pass through the various immature stages and become adult in a little over a month and a half. Under unfavorable conditions they may not reach maturity in less than two and a half months. Following is the approximate time which elapses when the insects occur under favorable conditions: From the time of the hatching of the egg to the first molt, 5 days; second instar, 5 days; third instar, 1 week; fourth instar, 2 weeks; fifth instar, 3 weeks. Under our conditions of climate the majority of the insects become adult between the middle of June and the middle of July. Ordinarily, mating takes place from two to three weeks after the insects become adult, and continues at intervals throughout the remainder of the summer. The males usually commence dying off about the first of September, while the

females commonly outlive the males, sometimes several weeks, when they deposit their eggs and die. This large species is a very voracious feeder from the time it reaches the second instar until maturity and death. It will even feed on its own mates when crippled or in any way unable to protect themselves. This is especially noticeable when molting, for at this time the insect, for a short period, is practically helpless. Their food consists mainly of caterpillars of various kinds. For a short period records were kept of the numbers of caterpillars these insects would kill. My first experiment was with a male and female. Following is the record of the caterpillars killed by the two insects between July 24 and August 17, 1913:

July 24	*Datana integerrima*	4	caterpillars	1 inch long.
July 26	*Halisidota caryæ*	4	caterpillars	1 inch long.
Aug. 4	*Datana integerrima*	4	caterpillars	1 inch long.
Aug. 8	*Datana integerrima*	4	caterpillars	1 inch long.
Aug. 11	*Datana integerrima*	4	caterpillars	Nearly full grown.
Aug. 16	*Callosamia promethea*	1	caterpillar	1½ inches long.

In another feeding experiment, using two adult males, between July 24 and August 15, 23 caterpillars were killed.

July 24	*Datana integerrima*	4	caterpillars	1 inch long.
July 30	*Datana ministra*	4	caterpillars	Full grown.
Aug. 4	*Achemon sphinx*	1	caterpillar	Full grown.
Aug. 8	*Datana integerrima*	6	caterpillars	Full grown.
Aug. 11	*Datana angusii*	4	caterpillars	Full grown.
Aug. 15	*Datana integerrima*	4	caterpillars	Full grown.

Apateticus maculiventris Say

These insects commence laying eggs under ordinary climatic conditions the latter part of May, or early June. The eggs are of a brownish-black color with a metallic luster, and measure about one-sixteenth of an inch in height and about one-third less across. They are oblong, oval in form, each being somewhat tapered at its base or at the point at which it is cemented either to leaf or bark. The top of the egg is quite broadly rounded, surmounted by a cap, around which is a circlet of about fourteen hair-like spines. At the time of hatching, this cap-like structure is pried open by the emerging insect. The number of eggs laid by a single individual varies to some extent. Commonly, the egg-laying period extends over two or three weeks, during which time the female deposits several clusters of eggs at intervals of a day or two between each laying. My records show that some insects deposit but three groups of eggs, while the greatest number was nine, deposited between June 28 and July 17, 1913. The most common number of eggs deposited at a single time is from 20 to 30. Thirty-five eggs is

the largest record I have for a single mass. These eggs hatch at the end of three days and the little, blood-red insects with black head and thorax remain massed together beside the egg-shells for three days with apparently no desire for food. At the end of this time they molt and at once start out in search of food, which consists for the most part of small, larval forms of insects. At the end of six days they again molt. The third instar lasts from four to five days, fourth instar from four to six days, and the fifth and final instar from seven to ten days. Under our conditions, we have from four to five broods per year. These insects are entirely predaceous, except possibly to a slight extent during the first instar when they may suck plant juices if they feed at all, which thus far is unproved. By nature they are very greedy, and kill many of our common insect pests when given the opportunity. During the early part of their life they show their preference for small insects such as aphids and recently hatched forms of beetles, moths and butterflies. I have found them feeding on almost every common form of caterpillar, the larval forms of beetles such as the elm leaf beetle, poplar leaf beetle, potato beetle, etc. I will say, however, that they show a great dislike to hairy caterpillars, such as the fall webworm, etc., and seem unable to exist on such food. The winter is passed in the adult stage in some sheltered place.

PRESIDENT GLENN W. HERRICK: The next paper will be read by Mr. H. A. Gossard.

THE DISTRIBUTION OF THE PERIODICAL CICADA IN OHIO

By H. A. GOSSARD

Three cicada years have occurred since I came to Ohio, and the accompanying maps show as accurately as I have been able to determine, the present distribution of the broods of 1906, 1914 and 1915. The brood of 1911 was due to occur in Hamilton County and that of 1912 in Champaign County according to Bul. 71, Bur. of Ent., U. S. D. A., but I have no data whatever to indicate whether these waning broods appeared according to schedule, or have become extinguished.

The map for the 1906 brood, or brood XIV of septendecim, according to Marlatt's numbering, is based upon 109 report cards, 55 of which recorded the presence of the insect and its general distribution in the counties of the reporters, and 54 of which recorded its absence. Most of the latter reports came from parties outside the zone of occurrence and served to fix, quite satisfactorily, the boundaries of the

brood. The dots on this map are distributed to show the areas infested and have no relation to the number of reports received. The squares indicate the presence of swarms. The crosses report absence of the cicadas. The following counties were found infested: Adams, Brown, Clermont, Clinton, Fayette, Gallia, Greene, Hamilton, Highland,

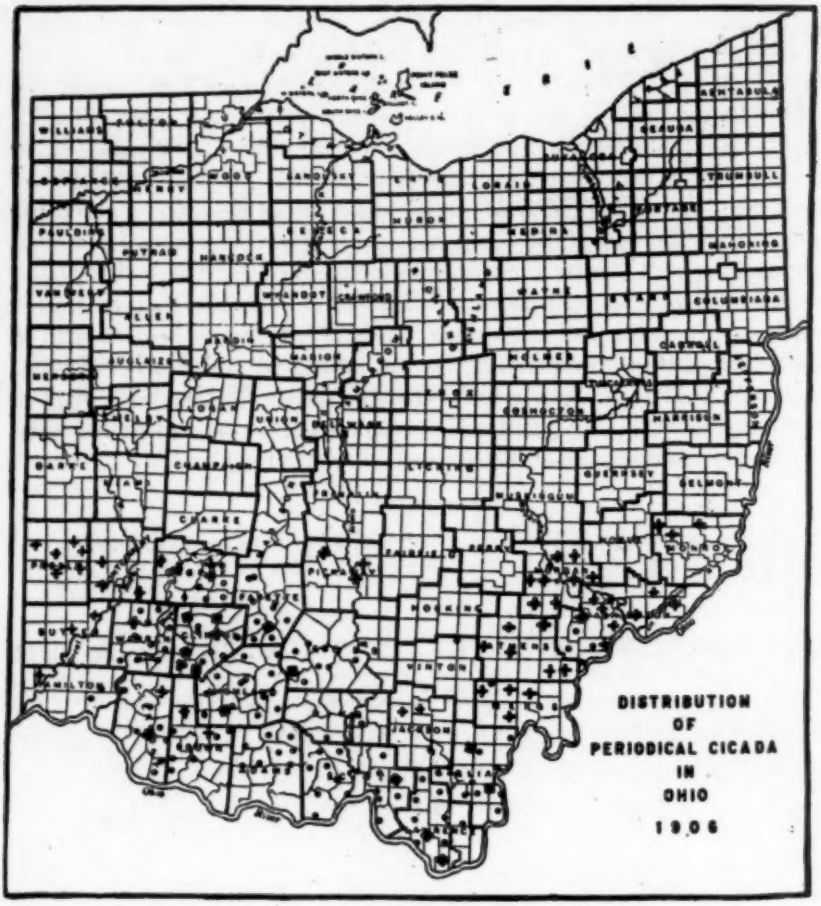

Fig. 2

Lawrence, Meigs, Morgan, Pike, Ross, Scioto, Vinton, Warren, Washington.

From the following counties, listed in Bul. 71, Bur. Ent., as occupied by the brood, I secured no report, but in all likelihood the insects appeared in some of them: Auglaize, Butler, Columbiana, Cuyahoga, Delaware, Jackson, Preble.

The map for the 1914 brood, or brood V of Marlatt, is constructed from 1,199 reports gathered respectively by the Experiment Station, 699, Ohio Division of Nursery and Orchard Inspection, 442, and the Ohio Biological Survey, 58. My thanks are hereby tendered to Professors Osborn and Shaw for the privilege of including their data

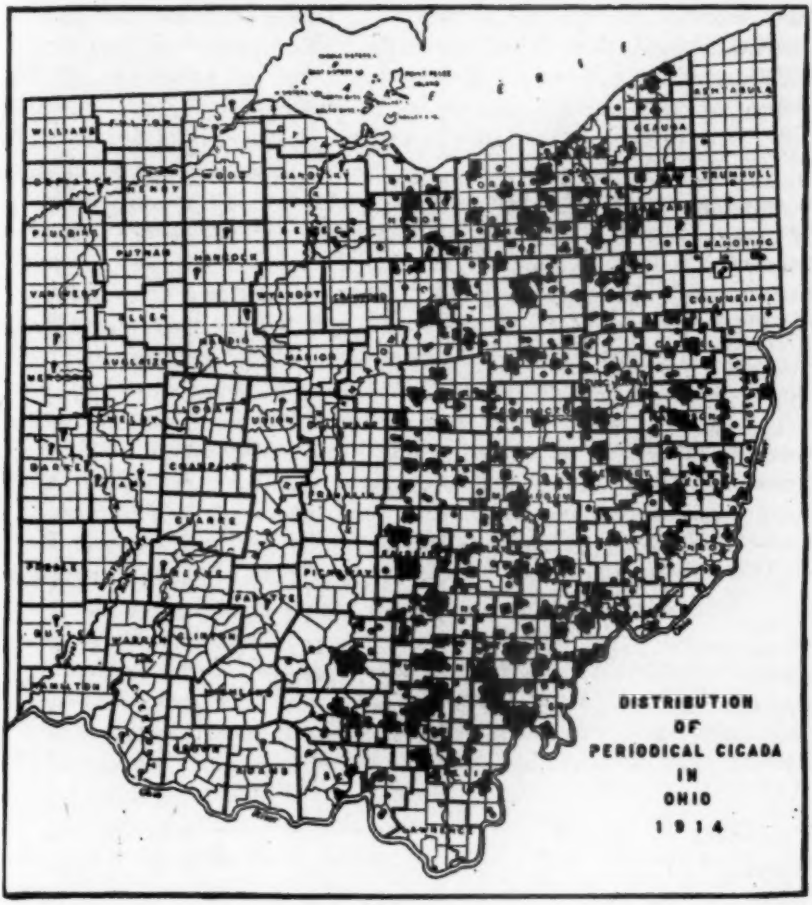

Fig. 3

in this report. Each dot or square represents one report, the whole being an accurate map of the brood. The squares indicate swarms. The accompanying grouping of counties according to latitude shows the respective dates of appearance and disappearance of the brood in the different zones, going from the southern to the northern parts of the state.

DATES OF APPEARANCE AND DISAPPEARANCE.

Counties	Appearance		Disappearance	
	Month	Date	Month	Date
Lawrence	5	15	?	..
Gallia	5	15	7	8
Scioto	5	16	6	30
Pike	5	15	6	20
Jackson	4	1	7	1
Meigs	5	9	7	25(?)
Ross	5	15	6	27
Vinton	5	5	7	4
Athens	5	20	6	30
Hocking	5	10	7	11
Washington	5	1	7	8
Pickaway	5	10	6	14
Fairfield	5	15	7	1
Perry	5	1	7	5
Morgan	5	15	7	6
Noble	5	1	7	4
Monroe	5	1	7	12
Licking	4	12	7	10
Muskingum	5	1	7	11
Guernsey	5	15	7	3
Belmont	5	15	7	3
Knox	5	15	7	22
Coshocton	5	10	7	4
Harrison	5	15	7	15
Jefferson	5	1	7	3
Holmes	4	1	7	10
Tuscarawas	5	15	7	15
Carroll	5	15	7	6
Crawford	6	8	7	1
Richland	5	1	7	13
Ashland	4	20	7	6
Wayne	5	20	7	6
Stark	5	15	7	2
Columbiana	5	30	7	15
Seneca	5	24	7	25
Huron	5	20	7	4
Medina	5	10	7	4
Summit	5	1	7	12
Portage	5	15	6	25
Mahoning	5	30	0	0
Trumbull	5	1	6	6
Erie	5	20	7	10
Lorain	5	1	7	12
Cuyahoga	5	15	7	4
Geauga	5	7	7	1
Lake	5	20	7	20

It will be seen from these reports that the records of first notice were as early in northern Ohio as in the southern part, but the dates of disappearance are progressively later, going toward the north. Since our reporters included pupæ as well as adults in their observations, there was probably a wider difference in the dates for the appearance of the adults in the respective sections than the records appear to show.

The interrogation points in several of the western counties, when considered in connection with what may be called the internal evidence of the report cards, indicate a strong probability that the cicada appears thinly but regularly in several neighborhoods in the western half of the state, entirely outside of territory heretofore mapped as inhabited by the brood.

While pupæ were observed and collected in large numbers at Wooster during the last ten days of April, no adults were recorded until May 25, when I heard their song in the woods about one and one-quarter miles northeast of town. They were plentiful 10 days later and commenced ovipositing June 5 and 6. A young orchard, newly set, had the tree tops covered with mosquito netting and the trunks wrapped with paper, the work beginning June 9 and being finished June 11, but considerable injury was done during the 4 or 5 days when the females were busy. The cost of this protection, including labor for putting on the protectors and later removing them, averaged about 5 to 7 cents per tree, but could have been reduced as much as 2 or 3 cents per tree under normal conditions. Some unprotected young orchards of a year's growth near Wooster suffered very severely. It would probably have paid to have protected them, even at a cost of 25 cents per tree.

Though a careful lookout was kept at Wooster for cicada chimneys, none were observed. Mr. J. L. King and Mr. C. A. Reese reported that at Sugar Grove, Hocking County, in the pine woods east of the Baumgartner farm, were acres of cicada chimneys so thick that one could not step without breaking some of them down.

The cicada adults were still plentiful and musical at Wooster, June 16, but were beginning to decline and by June 23 only a few stragglers were left. At Funk's Hollow, west of Wooster, Mr. S. G. Harry found them singing July 4 and 5, which, with one exception, was the latest record for Wayne County. The latest report was July 6, giving the adults an extreme period of 46 days for Wayne County. July 10, no song could be heard in any of the places where they existed less than a week earlier.

The map showing the distribution for 1915, or brood VI of Marlatt, was constructed from 227 reports of which 38 affirmed the presence of the cicada and 189 denied its occurrence, or else were evidently based on the supposition that some other species was *septendecim*.

I rejected all reports of occurrence after the first few days of July, though there is a possibility that some of the later reports really referred to belated specimens of the 17-year species. The fact that not more than one-fourth of my letters of inquiry brought any response indicated to me that the brood was very thin, and not a single card

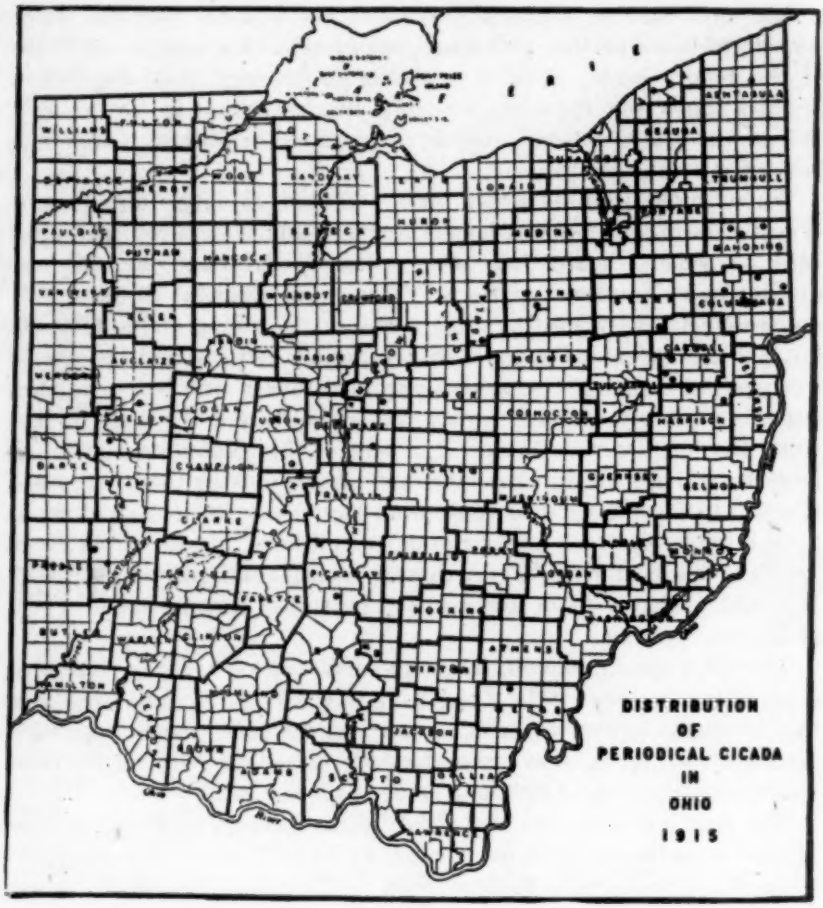

Fig. 4

reported a swarm. Nearly all the reports mentioned that only a very few specimens were seen or heard. In fact, if we were to rely upon this season's record alone, we might properly regard all of the insects appearing as stragglers of the 1914 brood. I doubt if they were sufficiently numerous in any part of the state to reproduce. County Agent Galehouse of Mahoning County reported that larvæ came

quite numerously to upper layers of soil in April and May, but did not subsequently appear as adults in any considerable numbers, so far as he could discover. It will be a matter of some interest to watch for their possible appearance next year in his county, since they may have been retarded by cold. Each dot on the map records a report of occurrence, often of only a single individual, or much less frequently of a very few specimens. The record for Wayne County is based on the song of 2 individuals, heard by J. S. Houser and Prof. Edmund Secrest, June 7, 1915; and for Ashland County, on the song of a single specimen heard by Messrs. J. S. Houser and E. B. Forbes at Loudonville, June 9, 1915. The counties containing the remnants of this brood are, according to these meager returns, Ashland, Ashtabula, Carroll, Columbiana, Delaware, Harrison, Madison, Mohoning, Meigs, Montgomery, Morrow, Pickaway, Shelby, Stark, Summit, Union and Wayne.

Comparing with Marlatt's record, Ashland, Harrison, Meigs, Stark and Wayne counties are added to the territory of the brood, and Champaign and Vinton counties fail of confirmation.

(By general consent discussion was deferred until after the presentation of the following paper by Mr. Gossard.)

IS THE HIVE A CENTER FOR DISTRIBUTING FIRE BLIGHT? IS APHID HONEY DEW A MEDIUM FOR SPREADING BLIGHT?

By H. A. Gossard

Seeking an answer to the above questions the following experimental work was performed during the season of 1914, the technical bacteriological work being done by Mr. R. C. Walton of the Station Botanical Department.

Honey and the Hive

Cultures were made from old honey taken from three different hives early in the spring in an attempt to learn if the bacilli of blight were carried over the winter in the hive. Both light and dark honey from each hive was sampled for this purpose. No specimens of the organanism of blight were secured from any of these hives.

In an attempt to definitely connect the hive with the transmission of the disease, cultures were also made, during the apple-blooming period, from five hives into which fresh apple honey had been carried from orchards which had blighted to a greater or lesser degree the

preceding year. These samples, like all others, were sucked from the comb cells into sterilized pipettes and we had the judgment of Mr. E. R. Root of Medina, Ohio, that the samples were largely fresh apple blossom honey with only a little admixture of dandelion. They, therefore, approximated as closely as honey samples could do, the composition of apple blossom nectar in which the bacilli are known to thrive. None of these samples yielded the blight bacillus. However, we do not positively know that blight bacilli were present in the blossoms to which the bees from four of these hives had access; we do definitely know that they were present in a large percentage of the blossoms on which the bees from one of the hives pastured, but from which we obtained no blight, though honey samples were taken from it at intervals up till midsummer.

To determine if it is possible for the organism to live in honey as it does in nectar, and inferentially, that the bacilli can be scattered from the hive, we inoculated with the blight organism samples of sterilized honey, of varying age, from the freshest nectar-like samples we could obtain from the combs to samples taken in midsummer, and then cultured from these samples at intervals for the purpose of determining how long the bacilli would remain virile in this medium. Cultures were made on agar and incubated in the laboratory and then parallel or confirmatory series of inoculations were made into young apple shoots. Both pure honey and 50 per cent honey, diluted with water so as to more nearly approximate the composition of nectar, were used. The number of cultures made was 176 and the number of inoculations made closely approximated 600. Some 400 to 500 check twigs were numbered and examined for comparison. After incubating in honey from 8½ minutes to several days, the organism was cultured by the poured plate and streak methods on 3 per cent neutral nutrient glucose agar. Growth of the organism was obtained from the 8½-minute incubation and also on intermediate incubations up to and including 43 hours and 25 minutes. This isolated organism, when inoculated into the growing tips of apple shoots, usually gave 100 per cent of infection on trees where no infection occurred on check or uninoculated shoots. The inoculated shoots were protected against other means of infection by being enclosed in paraffined paper bags. Some of the inoculations were made into the shoots of small potted apple trees kept growing in the greenhouse and among which no blight had ever existed. The results with these potted trees exactly agreed with those obtained when working with orchard trees.

A fresh culture of *B. amylovorus* was inoculated into a tube of unsterilized honey and incubated there from 4 to 47 hours. At the end of the 4th, the 28th, and the 47th hour, inoculations were made from

Inoculated tree with *B. amylovorus* after incubating in honey for 41 and 42 hours and then grown on 3 per cent neutral nutrient glucose agar.
931–942 Inoculated—100 per cent infected 943–954 Checks—free

Inoculated trees with *B. amylovorus* isolated from pure honey after 8 minutes, 1 hour, and 2 hours and 4 minutes incubation in it and then grown on neutral nutrient glucose agar.

461–473 Inoculated—100 per cent infection
Check tree—free

the infected honey directly into the tips of apple shoots. These inoculations gave 84, 64 and 52 per cent of infection, respectively, as against 0 per cent in the checks kept for comparison. These tests prove conclusively to us that the blight organism, in honey, can remain sufficiently virulent for 47 hours to produce infection, with the extreme time-measure of virulency probably not reached. Tests of this kind were made with fresh apple honey and also with well-ripened honey taken from the hive in midsummer, and the results were substantially the same.

It is evident from these results that the formic acid of honey is not immediately fatal to the blight organism, and, while we may guess, from the fact that we could get no infection after a certain limit of incubation, that the bacilli simply survive for a time without multiplying, we are unable to entirely reject the possibility of their multiplying in the comparatively raw nectar when it is first carried into the hive and has undergone but little of the curing process. Anyhow, we believe we have proved that if one bee carries 100,000 bacilli into the hive one day, that on the following one or two days, each of 1,000 bees has the possibility of carrying a considerable fraction of 100 virulent bacilli out to fruit blossoms, because practically all the bees in the hive are at work during the night curing the honey. This would seem to go a long way toward explaining the wholesale infection that occurs in the latter part of the blooming period. However, it must be remembered that this surmise, as yet, rests upon inference alone.

Aphid Honey Dew in Connection with Blight

From the similarity in composition of nectar and aphid honey dew, the habit of bees, ants and flies to visit it, and also because of the known relation of aphids to blight inoculation, we were interested to learn if blight bacilli could live for any length of time in this as they do in nectar and in honey. Two of the largest drops we could find on rolled apple leaves on potted trees in the greenhouse were infected with blight bacilli, and at the end of 20½ hours, 43 hours, and 71 hours and 20 minutes, young apple shoots of potted trees which had always been free from blight were inoculated, using the infected honey dew as the inoculum. These inoculations resulted in 66⅔, 83⅓ and 100 per cent of infection respectively.

In each important series of inoculations we made it our practice to reisolate our organism and prove the identity of the bacillus by cultures, microscopic examinations and reinoculations.

The habit of ants to visit colonies of woolly aphids, gathered in the spring around old but living blight cankers, and then of visiting the green aphids on the expanding buds, which are in turn visited by some

of the bees and by various flies, in quest of honey dew, may constitute a chain, the significance of which we can only conjecture at present; but, if the chain can be proved, we may possibly possess the key to blight control; at all events, to a more effective control than we have at present.

MR. T. J. HEADLEE: I would like to ask why neutral agar was used?

MR. H. A. GOSSARD: The technical part of the bacteriological work was done by Mr. R. C. Walton formerly of the Pennsylvania Chestnut Blight Commission. The chief purpose was to isolate the organism so as to obtain a pure culture and have it ready for use.

MR. T. J. HEADLEE: Is it likely that this method would increase the virility of the organisms?

MR. H. A. GOSSARD: I cannot answer that question.

MR. E. F. PHILLIPS: Is it assumed from Mr. Gossard's paper that honey bees carry out honey after it has been carried into the hive?

MR. H. A. GOSSARD: What we suspect is that the bees, in working over the honey at night which they have gathered in the daytime as infected nectar, become contaminated, the germs clinging to their mouthparts and possibly to their feet and, if so, the question is, will the germs remain virulent during the next one or two days.

These were the questions we were trying to solve. We assume, as a matter of course, that some honey will cling to their mouths and perhaps to their feet and hairs.

MR. E. F. PHILLIPS: The amount of acid in honey is very small. I should not suspect for one moment that the blight organisms would be killed by the action of this acid. In the case of certain brood diseases, the causal organisms remain for years in honey.

Honey is a fine medium for the preservation of any substance, particularly any bacterial organism. While it is suitable for the preservation of any material I do not see how these facts have any bearing on the pear blight situation for it must first be shown that honey actually becomes contaminated.

MR. W. A. RILEY: The question came up as I understand it regarding the spreading of germs from natural honey.

MR. H. A. GOSSARD: No. We made a number of inoculations and cultivated from them in order to prove the possibility of natural honey preserving the germs for a considerable period.

MR. W. A. RILEY: As suggested by Dr. Phillips I would like to know as to whether these germs would pass through the alimentary canal of the bee or whether they might live in the bee. I am curious

to know what would be done in case the latter occurred; whether it might furnish a key to the control of pear blight.

MR. H. A. GOSSARD: I think we would have to go back of the honey bee. In my opinion, the orchardist is dependent on bees whether they scatter blight or not. The question with entomologists and botanists, everywhere, who have watched the blight and have given any time to the investigation of it, is to explain the wholesale infection that comes in early spring just after blooming. We believe it will become necessary to determine where the bees first obtain the germs and break off this supply.

MR. J. H. MERRILL: In Kansas, in 1913, the green aphis was so abundant on the unopened apple buds that several orchardists sprayed and controlled them with a contact insecticide. Later in the season blight was prevalent in many orchards but it was noticed that there was practically none in those in which the aphids had been controlled.

In 1914, the aphids were not as abundant and but little blight was noticed.

In 1915, the aphids were as numerous as in 1913 and, at this time, a large number of orchardists sprayed their trees before the blossoms opened with a contact insecticide to control the aphids. Blight was very bad in Kansas orchards during 1915 but in all those in which aphids had been controlled it was almost a negligible quantity.

As these experiments have been carried on over several hundred acres of orchards and with the same results during three years' time, I feel quite justified in accusing the aphids of being one of the chief distributors of fire blight.

MR. H. A. GOSSARD: We have carried on similar experiments with aphids and have obtained similar results. They are quite important later in the season.

We are very dubious, however, about their being the only offenders.

PRESIDENT GLENN W. HERRICK: Is there any definite data that aphids transfer bacillus?

MR. H. A. GOSSARD: If I am not mistaken some of the men at Cornell have proved that aphids transmit it. Mr. Burrill of Wisconsin has proved it and we have done likewise at Wooster.

I did not care to touch upon that subject in the present paper, as it would be more suitable for a paper published at a later time. We have proved that a considerable number of insects transmit blight.

MR. T. J. HEADLEE: During the season, which has just passed, I have had the opportunity to observe the prevalence of blight in cultivated orchards in comparison with neglected plantings. The damage done by blight was undoubtedly much greater in uncultivated orchards, and this greater damage seemed to be directly correlated

with the greater succulence of the neglected trees induced by the exceedingly rainy season.

It seems to me that the type of cultivation is thus shown to be a factor in the prevalence of blight which may seriously interfere with evidence as to the blight-carrying power of aphis, for under just such conditions as have obtained in New Jersey last season, failure to spray (as would normally be the case in uncultivated orchards) may be followed by aphis and by most serious blight damage without there being any essential connection among them.

PRESIDENT GLENN W. HERRICK: If there is no further discussion this completes our program for the session.

Adjournment 4.30 p. m.

MORNING SESSION

Tuesday, December 28, 1915, 10.00 a. m.

PRESIDENT GLENN W. HERRICK: The first business on the program is the discussion of the presidential address and I will ask Dr. S. J. Hunter to act as chairman.

MR. S. J. HUNTER: The discussion of the presidential address is now in order:

MR. F. M. WEBSTER: It seems to me that the subject discussed by the president in his address is a most important one to us all, as it deals with the preparation of entomologists for their life work. It appeals to me particularly because I think I have more entomologists working under me directly than any other one man in the country and I continually find that much depends upon the training of these men. Professor Herrick has covered this subject very well. It is one of the most important ones with which we have to deal.

There are one or two points I would like to mention that will show you another side of the situation. For the most part I think that the men who have been trained are unfitted for their work although I have had some men working under me for a good many years. I would not know how to do the work better and I do not know any way that it can be done better. Some time ago Professor Herrick was selected to mark the Civil Service examination papers covering the entomological examinations for the Bureau of Entomology. I do not believe anyone could have been selected who would have done this more accurately than he has but he has kept me around the Civil Service Commission from the first day of July to the 31st day of December. In the last list of papers that were graded, many men were rated very low who should have been in the front rank, while men who were not

fitted for the work were placed near the top of the list. There is, therefore, no way of telling by an examination what a man's ability really is.

There is something wrong somewhere. That is the situation that we have to face who must use the output of the universities. As a matter of fact I do not care where a man comes from or whether he is an American or not, but I want a man who will do things and will do things no one else is able to do. It is hard work to get such men. Civil Service examinations do not produce them because they are not a satisfactory test of a man's ability.

In making up a staff at a field station I will not have two men from the same state if I can help it. I want men from different institutions who have been trained under different instructors. By arranging matters in this way it is possible to secure the very best that is in all the men. I have eighteen field stations, some of which are rather small. When a young man just out of school is placed with half a dozen men in one of these stations he soon finds out that he has most of his education to get, but being associated with men who are differently trained, he is bound to get a square deal. When it comes to a college absolutely fitting a man for his work they do not do it, and I do not believe I could prepare a set of Civil Service examination questions that would bring out a man's ability.

It seems to me that the instructors in the different universities should get together and do their best to improve upon the education of the entomologists and give them those things which will bring them up to date and make them better acquainted with conditions under which we are working today. Some of my men are doing things that were deemed impossible ten or fifteen years ago. These are the kind of men we must have if we are to make progress. The instructors in the universities act as the producers while we are the consumers. I do not say they are not doing their best and achieving the best results that are possible under our present educational conditions, but some improvements should be made in the future. I have been working with President Pearson of the agricultural college at Ames, Iowa, and hope that the course which is about to be started there will bring about an improvement over some of the courses now given.

MR. H. A. GOSSARD: I am sure that the Association in general has not been sitting still because they did not appreciate the President's address. I think he has succeeded in making so good an address that we do not differ from it but have accepted it in its entirety. I am sure everybody has appreciated the experiences narrated by Professor Webster and all of us meet more or less the same problems in the field. We must remember, however, that teachers cannot make over per-

sonality; they can do a great deal to educate, but the peculiarities of the individual cannot be changed. We must fit our problems to our men as well as fit the men to the various problems. We may have with us men who can do certain things and do them well and it is often better to set them doing those things which they can do well rather than to put them to doing things they cannot do so well. We must consider both the workers and the work to be done. The problem of adaptation is a double one.

Mr. S. J. HUNTER: The President in his address has touched upon some fundamental points in education, a number of which are receiving serious consideration from other scientific bodies interested in education.

One is whether it is advisable to encourage research work among undergraduate students. In this, I believe the concensus of opinion agrees with the President, that saner and more lasting results will come through research workers who have had a broad and fundamental training before entering the field of research.

Another point which the President dwelt upon, worthy of interest, is that in the teaching of entomology there should be a place for biography,—a study of men noted for the results of their research along biological lines. Their early training, their methods of study and style of presentation can not fail to give an incentive to promising workers.

A third point—that in the education of an entomologist, we should place little weight on the making of a living. A student's first consideration should be the quality of his fitness. Professor Webster, who has preceded me in the discussion of the President's address, has referred to the matter of Civil Service examinations. In this connection, the greatest difficulty we have found is in keeping men from taking these examinations before they were, in our opinion, ready to take up the work which the passage of such examinations assumes that they are ready to do.

MR. W. A. RILEY: I was in a committee meeting and so I did not hear the full address yesterday, but I think I know the viewpoint presented.

I have been especially interested in Professor Webster's remarks because it seems to me that they are comparable to those which are constantly being presented in the teaching work. From the teacher's viewpoint, you hear the complaint about the type of students, the type of preparation for college work. The question as to whether a student should be encouraged in doing this work or that, cannot be considered wholly on its merits, for as teachers we must take the material that comes to us. There is no arbitrary test in the general

educational systems that will do more than weed out a proportion of those unfit. A man may pass formal examinations with high grades and yet be wholly lacking in the most essential qualities which make for success.

As a course of study I believe that it is best to give a man a broad general preparation in entomology and then allow him to decide for himself the field in which he wishes to specialize. Some who come to us are not particularly fitted for any aggressive original work, but this is not a difficulty peculiar to college students of entomology.

MR. S. J. HUNTER: If there is no further discussion we will proceed with the regular order of business.

PRESIDENT GLENN W. HERRICK: We will now pass to the reading of papers. The first paper on the program will be given by Mr. F. B. Paddock.

OBSERVATIONS ON THE TURNIP LOUSE

By F. B. PADDOCK, *Texas Experiment Station, College Station*

Work was first undertaken with this species in the fall of 1913. Previous to that time the numerous inquiries which were received indicated that this insect was becoming very destructive over the entire state. When the investigations were started it was supposed that the insect was the cabbage louse, *Aphis brassicæ*. The statements made in literature at that time were that in the South during the winter the cabbage louse was a serious pest of turnips grown as a winter truck crop.

Very soon after the work was started it became evident that the species under observation was not the cabbage louse. Material was sent to Prof. C. P. Gillette and he determined it as a new species, *Aphis pseudobrassicæ*, just described by Mr. J. J. Davis. This determination was then confirmed by Mr. Davis. As soon as it was certain that the species under observation was not the cabbage louse, we took the liberty of calling it the "turnip louse," as that would identify it more readily for the truck grower.

This aphid has been reported to feed on the following hosts, named in order of importance as determined by our studies: Turnip, radish, mustard, rape, collard, rutabaga, cabbage, kale, kohl-rabi, bean and lettuce. It is quite possible that the presence of this aphid on the last two mentioned hosts was somewhat an accident and it is doubtful if the infestation could have persisted.

The normal form of reproduction in this aphid in Texas is asexual throughout the entire year. It seems that each generation is made

up entirely of viviparous females, as no sexes have so far been observed in the fields or in the cages. The farthest north in Texas that observations were made on this species was Wichita Falls, just south of the 34th parallel. It is evident that at this point sexes do not occur and the viviparous females survive the winter. Mr. Davis has written that the sexes have not been found in their search at West Lafayette, Indiana.

At College Station the winter temperatures are seldom low enough to prevent reproduction, though the daily number of young produced is very small. There are a few days when the lice, especially the old ones, do not reproduce. At Wichita Falls the winter temperatures of 15 to 20 degrees F. are not uncommon and frequently the temperature may remain below 32 degrees F. for five to seven days at a time. Often during the cold spells as much as one inch of snow may remain on the ground for a few days. Under such conditions the lice do not reproduce but reproduction takes place when the warm temperatures prevail. But few lice succumb to the cold at this point, these being the very old lice. At Brownsville, near the 26th parallel, the conditions in January are similar to those which exist at College Station in October. The daily young produced in the fields is four to six.

With the approach of the hot, dry weather of the summer there is a decided reduction in the daily young produced and all stages in the life-history are lengthened, the same as under winter conditions. It is quite evident that the summer conditions in Texas are even more trying than the winter. There are four to five months of very unfavorable conditions during the summer.

In 1914 a first-born generation series was started on January 18 and continued until August 6. During this time twenty generations of lice were born. This work was started again on September 14, 1914, and continued until the same date in 1915. During this period of exactly twelve months, thirty-five generations of lice were born. The average total young produced by the generations of the first series was 80, by the second 93.

Two other species of aphids were found to feed on the same host plants as the turnip louse. These are the cabbage louse and the "garden aphis," or green peach aphis, *Myzus persicæ* Sulz. Often one or both of these species might be found feeding on the same plant with the turnip louse, sometimes the colonies of the two species would over-lap. Both of these species have been confused with the turnip louse, even by entomologists. The cabbage louse was most often found on cabbage, but in the spring of 1915 it was common in the flower heads of mustard and turnip. From the observations made in this study it could be said that the turnip louse is most generally

found on turnips and radish, whereas the cabbage louse is usually found on cabbage. The cabbage louse seemed to be more hardy than the turnip louse. The garden aphis was found abundant on turnip and radish at all times. This species was very closely associated with the turnip louse. It was much more hardy and consequently bears very interesting biological relationships. The garden aphis proved to have a far greater adaptive capacity and so it could withstand far more unfavorable climatic conditions. In times when the turnip louse was absent from the fields this species served as a host for the natural factors of control. The parasites would not work on the garden aphis until the turnip louse was very scarce, but in this way the parasites could maintain themselves in numbers until the turnip lice might appear again. The garden aphis seemed to be free from the attacks of the predaceous enemies as long as an ample supply of turnip lice was present. The most wonderful of the seemingly selective power was that of the fungous disease. This disease proved destructive to the turnip louse when the garden aphis flourished. It was only when the numbers of turnip lice were very reduced that the garden aphis died from the disease. The garden aphis did not seem to be affected as much by the low temperatures as did the turnip louse.

The natural factors of control, which were present to a greater or less extent over the state, exerted a very marked effect on the turnip louse. In some sections the turnip louse was held in check so effectively that it was not feared as a pest. Observations were made on two species of parasites, three species of coccinellids, two species of syrphid flies, one species of chrysopa, and a fungous disease.

The most widely distributed parasite was *Lysiphlebus testaceipes* Cress. This species was always found in numbers in the northern part of the state in those localities where the "green-bug" has been destructive. This parasite always proves very effective in the control of the "green-bug." The other parasite, *Diæretus rapæ* Curt., was present in great numbers at College Station, and to a limited extent in the southern sections of the state. From the observations made it is evident that the life-history and habits of these lice parasites are quite similar.

Some interesting results were noted of the effect of temperature on the development and activities of *Diæretus*. The last week of December 1913 was very cold but the first week of January 1914 was quite mild. On January 9, adult *Diæretus* were taken in the outdoor cages. This brood continued to emerge for a period of over one week. On January 17, dead parasitized lice were again observed in the outdoor cages. During these first seventeen days of January the average

daily mean temperature was 50° F. Evidently this temperature does not prevent the development or activities of the parasite. From the dead lice which were collected on January 17, adult parasites emerged sixteen days later, or on February 2. The average daily mean temperature during this period was 59° F. On the night of February 6, the unusual temperature of 17° F. occurred. Lice which died on February 2 and were exposed to this cold were collected. Fifteen days after the lice died and eleven days after the freeze, parasites emerged from these lice. During this period the average daily mean temperature was 49° F.

The parasites were present only in limited numbers during the period from September 1914 to May 1915. During this time the importance of predaceous enemies was strikingly demonstrated. In four widely separated sections of the state the turnip louse was held in check by coccinellids. The presence of the predaceous enemies was much more constant over the state than the presence of the parasites.

The coccinellids were found to be always present where the turnip lice occurred. Three species were found over the state. They are *Hippodamia convergens* Guer., *Megilla maculata* DeG., and *Coccinella munda* Say. The first two named species were about equally abundant and the last was present only in limited numbers. In some sections of the state the spotted lady-beetle was called the "cold weather" lady-beetle. Our observations seemed to bear out the general statement that *H. convergens* is the more active and abundant in the fall and spring and *M. maculata* is the more active and abundant during the winter.

The syrphid flies were widely distributed over the state. At College Station they were quite numerous at times. *Syrphus americanus* Wied. was found generally distributed over the state. In the southern part of the state the oblique syrphid, *Allograpta obliqua* Say, was often found. In the spring of 1915 this species was also taken at College Station.

The chrysopa fly was usually found in all fields where the turnip louse was abundant.

The fungous disease is a factor of natural control which was very interesting on account of its sudden appearance and its effectiveness in eradicating the turnip louse. The fungus which was observed was undoubtedly *Empusa* sp., probably *Empusa aphidius*, though four species of this genus have been reported from Aphids.

This fungus was first noticed in the fall of 1913 on November 12. At this time many dead lice were found; some were orange in color and soft while others were brown and dry. These lice were mostly pupæ, though there were some immature apterous, and a few winged

lice. In just a week after the disease was first observed fully 30 per cent of the lice on the plants were dead from it. At this time most of the dead lice were immature apterous, and only a few pupæ and some winged lice. By the end of another week the lice were almost entirely destroyed by the fungus.

In the outdoor cages on January 7, 1914, the lice were found to be dying rapidly from the fungus. The previous week had been mild, though the last week in December 1913 had been very cold. The dead lice at this time were mostly apterous and only a few winged lice. By the end of a week the fungus had killed practically every louse in the outdoor cages. The average daily mean temperature during January 7 to 14 was 51° F. The fungus was again found in the outdoor cages on February 10. This was just four days after the low temperature of 17° F. The fungus was prevalent in the outdoor cages next on March 10. Two weeks later most of the lice had died. On March 30 the disease was widespread in the louse-infested fields.

Extensive experiments, extending over a period of two years, were conducted on the artificial control of the turnip louse. It was found that spraying was effective when properly done with a good material. The soap solutions gave very satisfactory results. For the reason that the whale-oil soaps are not generally available in Texas, laundry soap is recommended. The secret of efficient application is in the use of an extension rod, a 60° elbow, and an "angle" type nozzle.

PRESIDENT GLENN W. HERRICK: I would like to ask Mr. Paddock if the turnip louse has the same pubescence as the cabbage aphis.

MR. F. B. PADDOCK: The first distinguishing point between the two species is that the turnip louse is bare and the cabbage louse is covered with pubescence.

PRESIDENT GLENN W. HERRICK: We will now listen to a paper by Mr. William Moore.

FUMIGATION OF ANIMALS TO DESTROY THEIR EXTERNAL PARASITES

By WILLIAM MOORE, *Assistant Professor of Entomology, University of Minn.*

INTRODUCTION

During the past summer, a number of experiments were undertaken at the Minnesota Experiment Station in a search for new insecticides. The first work was with a number of essential oils in the hope that some of these might prove valuable repellents to insects. It was

found, however, that most of the essential oils would injure plants when applied to them and when put on animals, the relief obtained from even the best was dependent upon the abundance and the hunger of the attacking insects. Several oils are valuable against mosquitos, but if in a locality where mosquitos are extremely abundant and very hungry, the results are not so good.

Toxicity of Nitrobenzene.

The next group of compounds to be studied was the benzene series and the compound selected for the first week was nitrobenzene. It was found that one drop of nitrobenzene placed on a piece of filter paper and allowed to evaporate under a bell-jar containing approximately one cubic foot of air, would destroy the adult white fly on a plant in about one hour to one and a half hours. In looking through the literature to ascertain the toxicity of nitrobenzene, it was found that nitrobenzene is considered to be a very serious poison. Blyth[1] mentions a number of experiments showing that nitrobenzene is extremely poisonous. One experiment cited was that in which a cat was exposed under a glass shade in which 15 grams of nitrobenzene were evaporated on warm sand. The animal immediately showed symptoms of poisoning. After thirty minutes' exposure, when the shade was removed to introduce another 15 grams, the cat for a moment escaped, but was recaptured and replaced under the shade and in one hour and forty minutes was dead. He also cites the case of a man who died from the effects of nitrobenzene which had been spilt upon his clothes, to show that the vapor of nitrobenzene is poisonous. Filehne[2] cites a case in which he placed a rabbit in a large glass bottle into which he led strong nitrobenzene vapor. In a half-hour, the animal was no longer normal in appearance and in forty minutes was lying upon its side. He states that if the animal is then removed, in from a half-hour to two hours, it will return to its normal condition. If, however, it is not removed, the animal will die. Haines[3] states that nitrobenzene is poisonous when taken internally, when inhaled as a vapor, or when absorbed by the skin. He even stated that symptoms of poisoning may result from the use of almond glycerine soap, which contains nitrobenzene, particularly when used in hot water. Holland[4] states that nitrobenzene breaks down the blood corpuscles forming methemoglobin and paralyzes the nerve centers, the immediate symp-

[1] Blyth, Poisons and Their Effects and Detection, third ed., p. 184.

[2] Filehne, Ueber die Giftwirkungen des Nitrobenzol Archiv für Experimentelle Pathologie and Pharmakologie, Vol. 9, 1878, p. 342.

[3] Peterson & Haines, Textbook of Legal Medicine and Toxicology, p. 606.

[4] Holland, Medical Chemistry and Toxicology, 1915, p. 438.

toms, not being noticed for a few hours, are vividness of the face, bluish nails, feeble pulse, cold skin, giddiness, vomiting, and coma, sometimes complicated by convulsions, and finally death. If death is not prompt, jaundice may ensue. He states that symptoms similar to that of hydrocyanic acid poisoning has been induced by inhaling vapor in the industries where nitrobenzene is used. In order to ascertain exactly how poisonous nitrobenzene would be to animals, a large white rat was placed in a fumigation box of about six cubic feet and a drop of nitrobenzene to each cubic foot evaporated therein, the rat being exposed for a period of one hour. No symptoms of poisoning were noticed at the time the rat was removed nor later. Another rat was fumigated for three hours at the same rate without disastrous results. The dose was increased to four, then 24 and finally 40 drops per cubic foot for the same time without injury to the animal. It was then found that more nitrobenzene was used than could be contained in the air, the surplus condensing on the sides of the box. It was discovered that about two to three drops of nitrobenzene would saturate a cubic foot of air, making allowance for some to be absorbed by the wood of the sides and bottom. The next question was to determine how long the rat could live in the saturated air. A rat was placed in a larger fumigation box containing about 180 cubic feet. Sufficient nitrobenzene was evaporated to saturate the atmosphere and food was placed in the box. The rat was alive and active at the end of 24 hours, when he was noticed eating the food in the box. At 36 hours, the rat was alive but somewhat sluggish and at the end of 48 hours, he died. The experiment is not conclusive as the rat was forced to eat food which probably contained nitrobenzene. Also the lack of oxygen may have affected the results.

Fumigation with Nitrobenzene

The question immediately arose—If nitrobenzene is no more poisonous than here cited to higher animals, but is poisonous to the insects, why not fumigate the animals to kill their parasites? It was found that if a dog was placed in a fumigation box and sufficient nitrobenzene introduced to saturate the atmosphere, the fleas would leave the dog in about a half-hour and would be quite dead at the end of an hour and a half. A dog thus treated showed no signs whatever of injury. Experiments were conducted with hogs infested with lice and it was found that a longer exposure was necessary to kill the lice, six to eight hours being necessary to completely free the hog of lice. In this case, also, most of the insects left the animal before dying. No effects of poisoning were discovered. A cross-bred sheep with a very thick dense wool was next tried. An exposure of twelve hours removed about 90 per

cent of the ticks from the wool, but when picked up and kept in a vial, they revived in about twelve to twenty-four hours. Those left in the wool did not revive. Even though the ticks might not be killed with this exposure, by removing them to the floor of the box, one could easily destroy them later, by spraying the floor with some strong sheep dip. This is of particular value as sheep in wool cannot be successfully dipped. The fumigation did not kill the puparia. Chickens were fumigated and it was shown that, in eight to ten hours, all the lice on the chicken could be destroyed. In a chicken house which was fumigated the red mites were also killed. The mite causing scaly leg of chickens can also be destroyed by a ten-hour fumigation. The Texas cattle fever tick cannot be obtained in Minnesota on the animals, but specimens received from the South and fumigated in glass vials were killed by a ten-hour exposure. Most of the specimens of ticks were fully engorged females laying or about ready to lay their eggs. One case of interest was that of a female which had started laying, probably having laid a quarter of her usual number at the time of fumigation. The tick was killed by the fumigation and no further eggs were laid. It might be noted that the engorged female ready to lay or laying, is probably the most difficult to destroy.

The Effect of Nitrobenzene on the Animal

So far as could be noticed, the animals showed no signs of poisoning under normal conditions. They all fed readily when removed from the box, and when compared with normal animals, were indistinguishable. A dog fumigated for six hours was normal in heart beat, respiration, and temperature. A count of the red blood corpuscles of a guinea pig before fumigation and after fumigation showed little change. Five million four hundred thousand red corpuscles per cu. mm. were obtained before fumigation. After fumigation for 12 hours and a half the blood count obtained showed 6,040,000. Twenty-four hours later showed 6,320,000. In 48 hours, 5,840,000. Such slight differences might well be obtained by experimental error in the count. In order to determine whether nitrobenzene would have any injurious effect upon the animal when repeated a number of times, guinea pigs were obtained and divided into two groups, a fumigated set and a normal set. Each set contained one full-grown male, one young male, one full-grown pregnant female, and a litter of young, the mother of which was not fumigated. The one set was fumigated over night, the exposure varying from 12 to 13 hours and repeated each week.

When the pregnant female in the fumigated set gave birth to her young, they were fumigated along with the mother animal. The old males remained normal, varying slightly from week to week. The

old male in the normal set increased somewhat in weight, apparently not being quite full-grown. This was not true of the old male in the fumigation set, but this was not due to the fumigation, as he had been in my possession for six weeks previous and had not gained. The

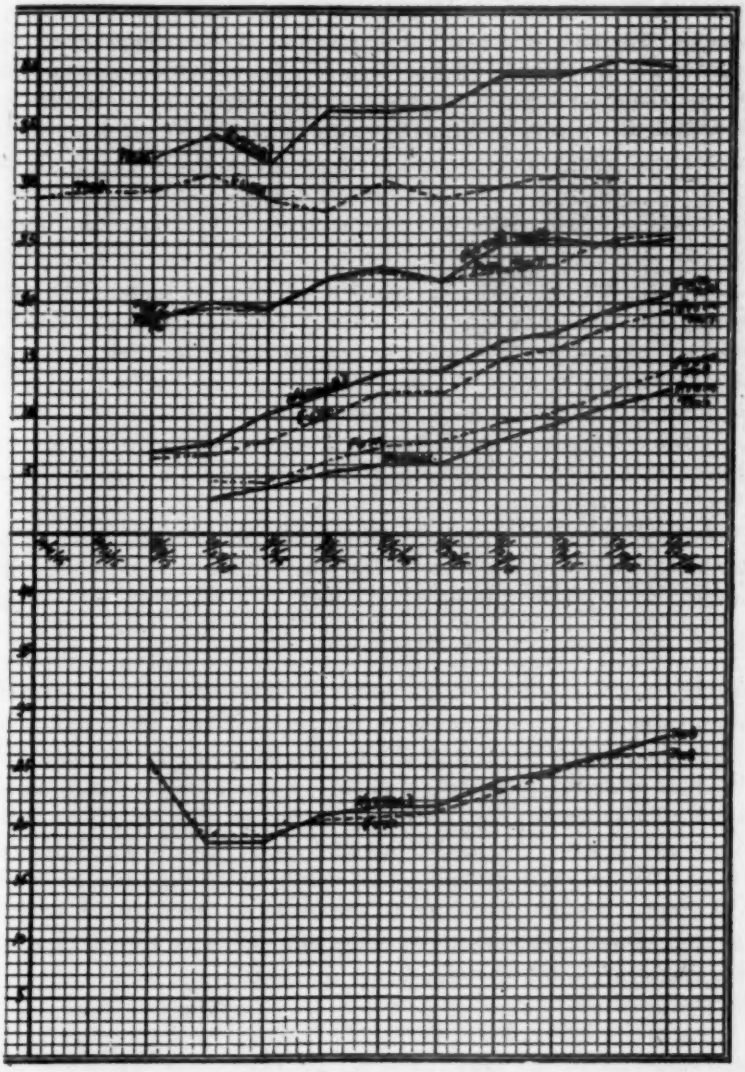

Fig. 5. Curve of growth of fumigated guinea pigs. No. 1 a male and nos. 16 and 17 young males. Average weights of litters of young from nos. 6, 7, 8 and 11. Nos. 6 and 8, females, were pregnant at the beginning and end of the experiment.

young males increased slightly in weight with practically no difference. The young gained regularly in both sets and no difference was shown between the young fed by a normal animal and the young fed by a fumigated animal. The female guinea pigs were perfectly normal. There was no abortion, although nitrobenzene has been used to produce abortion. These animals have now been fumigated for nine continuous weeks and the two sets are indistinguishable. One large male was fumigated for ten weeks and was then killed and his tissues examined. So far as could be noticed, macroscopically, there was no injury, but microscopically a very slight congestion was noticed in some of the slides of the lung, but not sufficient to affect the animal. It was noticed that chickens which had been fumigated retained the odor of nitrobenzene in their bodies for several days after fumigation. Fumigated chickens lose this odor in five to seven days after fumigation. A short-horn cow was obtained and fumigated over night. The milk was tested by a number of people, some of whom noticed no difference between the milk of the fumigated animal and normal milk while others detected a very slight trace which, however, they agreed would have passed unnoticed under normal conditions. Milk will take up nitrobenzene if the cow is milked in the same room in which the cow had been fumigated. The milking 24 hours after fumigation showed no trace of nitrobenzene.

Some animals seemed to be more susceptible to nitrobenzene than others. An exposure of ten to twelve hours in a saturated atmosphere of nitrobenzene would produce the death of a cat while guinea pigs, sheep, etc., are not injured by a similar dose. It is, however, a well known fact that cats are particularly susceptible to coal tar derivatives. This does not detract from the value of nitrobenzene in destroying fleas on cats, as they easily stand a fumigation of one and a half hours. The nitrobenzene is taken into the lungs and hence to the blood from which it is probably removed by means of the kidneys. Herbivorous animals which urinate frequently seem to be less affected. The author and another person remained in a small room while it was fumigated with nitrobenzene for one and a half hours, destroying the house flies in the room. A slight irritation to the eyes and throat and a sweetish taste at the back of the mouth were the only symptoms noticed and no after-effects were discovered.

The Influence of Temperature

Professor Derby, of the University of Minnesota, Department of Physical Chemistry, worked out the amount of nitrobenzene which would saturate an atmosphere at different temperatures. From the curve, it is seen that at 83° F. about one drop is contained in a cubic

foot, while at 40° F. only about one-tenth of a drop will be held by a cubic foot of air.

Probably most of the results cited in the early portion of the paper, on the poisoning properties of nitrobenzene, were due to what might be termed super-saturated atmosphere in which the nitrobenzene was condensed as tiny particles in the air. In all of our later experiments, the nitrobenzene was allowed to evaporate from a cloth and not evapo-

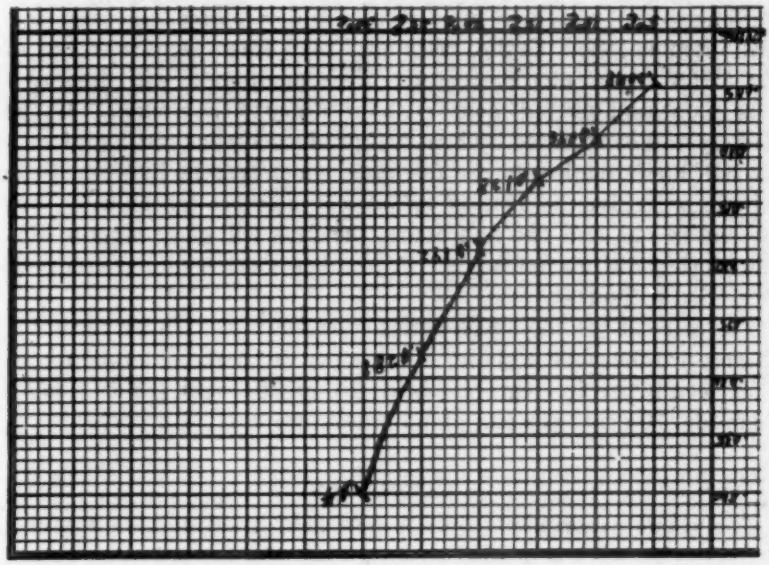

Fig. 6. Curve showing amount of nitrobenzene in grams to saturate an atmosphere at various degrees centigrade.

.13695	drops of	C_6	H_5	NO_2	at	40° F.	per	cu.	ft.
.262944	"	"	"	"	"	"	50° F.	"	"	"
.350592	"	"	"	"	"	"	59° F.	"	"	"
.47808	"	"	"	"	"	"	68° F.	"	"	"
.778832	"	"	"	"	"	"	77° F.	"	"	"
1.0956	"	"	"	"	"	"	86° F.	"	"	"

rated by heat. In the experiments cited from other authors, in most cases, the vapor of nitrobenzene was used, heat being applied to obtain it, and under such conditions probably as much as a drop would be contained in a cubic inch rather than a cubic foot. Although one can successfully fumigate chickens by an exposure of ten to twelve hours, by evaporating the nitrobenzene from a damp cloth, the same exposure to a super-saturated atmosphere obtained by evaporating the nitrobenzene by heat will kill the chickens, producing paralysis. The

difference between the results of other workers and my own apparently is dependent upon the method used.

Other Benzene Derivatives Giving Similar Results

After having obtained results with nitrobenzene, Mr. Marcovitch, working with me, tried out a number of similar compounds. Paradichlorobenzene will kill the fleas on a dog in about two and one half hours. Paradichlorobenzene seems to be less poisonous than nitrobenzene and one cannot obtain as good results in destroying the sheep tick as with nitrobenzene. Ortho, meta, and para cresol were tried but only the ortho cresol was successful. This compound will destroy the fleas in one and one half hours without injury to the animal. Carbolic acid crystals evaporated by heat will produce similar results in one and one half hours, while salicylic aldehyde, which is ortho hydroxyl benzaldehyde, will drive the fleas off the animal in five to ten minutes, but at the end of one and one half hours, the fleas will show signs of life, although they die in a few hours. A number of other similar compounds were tried without success.

The price of the chemicals varies considerably. Under normal conditions, nitrobenzene is about 20 cents per lb.; paradichlorobenzene, 25 to 30 cents per lb.; carbolic acid, 25 to 30 cents per lb.; salicylic aldehyde, 70 cents per oz.; ortho cresol, *about $1.00* a pound.

Conclusion

The above experiments open a new field in economic entomology. Considerable work is needed to determine why the poison will destroy an insect without injuring the animal. Experiments on a large scale, such as the fumigation of barns, must be conducted. The chief difficulty in Minnesota is the low temperature of the barns in the winter, which prevents sufficient nitrobenzene being held in the air to produce the desired results. As many entomologists, particularly those in the southern states, have better opportunities to study these chemicals under different conditions and on different insects, it is hoped that others will undertake experiments along this line.

From Division of Economic Zoölogy,
Minnesota Experiment Station,
St. Paul, Minn.

President Glenn W. Herrick: Is there any discussion of this paper?

Mr. E. P. Felt: I would like to ask if nitrobenzene is explosive.

MR. WILLIAM MOORE: It is not. With the dose used it would be possible to have an oil stove in the same room. (Phial of nitrobenzene passed around for inspection.)

MR. W. A. RILEY: I should like to inquire whether the docility of the cat when taken from the box was due to its being under the influence of the chemical? What effect does it have upon a dog?

MR. WILLIAM MOORE: It may have a more or less quieting effect upon the animal. The cat is more sensitive to the nitrobenzene than the dog, while the lack of oxygen in so small a box probably had an influence.

MR. W. A. RILEY: It is a paper of exceedingly great value in that the compound may be applied under ordinary conditions. I wondered if it was a question of applied psychology that as the paper started out with the details of the poisonous effect of the chemical, attention was focused on possible dangers of its use.

PRESIDENT GLENN W. HERRICK: I have been very much interested in the paper. We have been doing some work at Cornell on the use of paradichlorobenzene for some subterranean insects. Mr. Hawley, a graduate student, has been working along these lines with the white grub. I have been intensely interested in this project.

I should like to ask, have you arrived at any idea concerning the quantity one should use?

MR. WILLIAM MOORE: Under ordinary conditions probably two or five drops will be sufficient to saturate 1 cubic foot of air and make allowance for absorption by the wood. By saturating a cloth with nitrobenzene and tacking it in the box it will saturate the air sufficiently for effective treatment, during the night.

MR. W. C. O'KANE: What is the effect on plants?

MR. WILLIAM MOORE: In greenhouse fumigation it is not effective. You can saturate the air and kill the insects but it injures the plants. I might say that we are getting results with paradichlorobenzene. We have fumigated grain without injuring germination, in fact some grain so treated germinated more rapidly.

MR. W. C. O'KANE: What are the results on insect eggs?

MR. WILLIAM MOORE: I do not think it will destroy them.

MR. GEORGE A. DEAN: In your discussion you spoke of the nitrobenzene as hastening the germination of the seeds. I should like to know whether you have carried on any experiments or have any data as to the repellent properties of nitrobenzene. The reason that I ask this is because in Kansas, where we are carrying on experiments for the control of the kafir ant, we are trying to find some substance, with which the seed can be treated, that will act as a repellent and not injure the germination. I might say that we have found that one

of the methods of control for the kafir ant is to handle the ground in such a manner as to hasten the germination of the seed, and since, as you have stated, the nitrobenzene seems to accelerate the germination, I was thinking that, if it would also act as a repellent, it would be an excellent thing with which to treat the kafir seed.

MR. WILLIAM MOORE: It acts somewhat as a repellent to insects as insects leave the animal when fumigated.

MR. GEORGE A. DEAN: Does the seed retain the odor for any length of time?

MR. WILLIAM MOORE: For quite a long time. Seed treated by fumigation with nitrobenzene will retain a certain amount of the chemical but this will not injure the germination if the grain is in the soil. When a germinator is used the young shoots will be injured by the nitrobenzene which has evaporated into the air of the germinator.

PRESIDENT GLENN W. HERRICK: We will next listen to a paper by Mr. H. A. Gossard.

THE CLOVER LEAF-TYER (ANCYLIS ANGULIFASCIANA ZELLER)

By H. A. GOSSARD

In early April, 1905, my attention was attracted to the ragged, eaten condition of the clover leaves on the Station farm. A great army of small, leaf-tying caterpillars were found to be responsible for the damage. The injury rivaled that inflicted at the same season by the clover leaf weevil, *Phytonomus punctatus*. A little later a swarm of small tortricid moths appeared in the field, the chrysalid shells being numerously exposed in the trash and among the leaves where the caterpillars had fed. Investigation failed to discover any like degree of damage being inflicted elsewhere, so the insect was not specially followed up at the time, but was kept under observation through several succeeding seasons. I have not since seen it do so much damage as in 1905, but every year it is a somewhat inconspicuous inhabitant of Ohio clover fields, doing more damage than one is likely to suspect.

Dr. C. H. Fernald confirmed a lucky guess I made as to its identity, after he had compared my specimens with three of the original specimens from which Zeller wrote his description, these having been given to Dr. Fernald by Zeller. With the exception of a brief note by Dr. Fernald on the species, in Psyche, V. 3, and a similar note by the same writer in Trans. Am. Ent. Soc., V. X, there is no literature relating to it, except Zeller's description of the adult published in the Verhandlungen der k.-k. Zoölogisch botanischen Gesellschafft, Vol. XXV, 1875, and a few bibliographical references.

Food Plants and Character of Damage

The known food plants are the common red, alsike and white clovers. From laboratory tests I conclude that alfalfa is scarcely or not at all eaten.

Clover foliage eaten by the caterpillars presents a ragged appearance, the epidermis from one of the surfaces being either partially or wholly eaten away, while the epidermal cover remaining appears thin, papery and white, except for minute splotches and streaks of green here and there, which, through chance, were left uneaten. Either the upper or lower surface will be eaten, whichever happens to be turned inward in the cell in which each caterpillar ensconces itself. When newly hatched, the young caterpillar chooses some natural or accidental depression or crease in the leaf surface, such as overlies the midrib, and ties the opposing surfaces together by a fine, whitish expansion of silk, this with the leaf-walls forming a hollow tube within which the caterpillar hides and feeds; or, very often, two leaflets, one of which overlies the other, will be tied together with silk and the caterpillar will feed between them. Such leaflets may be on the same or on different petioles. As the caterpillars grow older they show a tendency to construct cells of considerable size, usually three-sided, each side consisting of a leaflet. When full grown the caterpillars make a thin, white cocoon of silk within their cells, and pupate.

Life-History

There are three broods per season. The first brood of moths appear in late April and early May and are nearly all gone by May 20, stragglers holding on till mid-June. The eggs are laid on the leaflets, hatch in two or three weeks, and the caterpillars come from about June 1 to June 20. The pupal period lasts from seven to fourteen days and the second brood of moths range from about July 1 to July 20. The second brood of caterpillars are at work from about July 20 to August 15. The second brood of pupæ come from about August 15 to September 20. The last brood of larvæ feed from the middle of September until some time in November, when they spin about themselves light, white, silken cocoons like so many of their family relatives, and thus spend the winter, possibly feeding a little in mild weather. They feed voraciously in early April, must pupate about the middle of that month, and issue in late April and May as the first brood of moths.

Remedies

From this life-history it is apparent that the first clover harvest will carry to the mow most of the larvæ and pupæ of the first brood,

and that the second cutting will take off many of the second brood. Fall pasturage will destroy many of the third brood. The present well-established customs for harvesting and pasturing clover furnish a logical and effective program of control.

PRESIDENT GLENN W. HERRICK: The next paper is by Mr. J. S. Houser.

DASYNEURA ULMEA FELT—A NEW ELM PEST

By J. S. HOUSER

Reference to this insect in entomological literature has been made but three times previous to the present. In 1907 and 1911, Dr. Felt merely referred to it and in 1913 he described the adult form. In the latter article, immediately preceding the technical description, Dr. Felt states:

> This dark brown species was reared May 7, 1888, from aborted elm buds evidently taken in the vicinity of Washington, D. C., presumably by Mr. Pergande. Apparently the same gall was collected at Jamaica Plain, Mass., by J. G. Jack.

So far as the writer has been able to determine, the above constitutes the complete recorded distribution of the insect to date. It was found first in Ohio, September 21, 1914, infesting an elm used as a street tree, Oakland Ave., Dayton, O.; later in 1914 and in 1915 it was observed in a number of places in Cincinnati, O.; July 25, 1915, a small elm was observed at New Matamoras on the Ohio River; and July 27, 1915, an additional small elm, at Mineral, O., was observed to be infested. Adults bred April 28, 1915, from Dayton material, were sent to Dr. Felt who very kindly identified them. Adults have not been bred from galls taken at other places, identification having been based upon the very characteristic gall only. It may be of interest to note in passing that the writer has been able to secure adults only when infested twigs were collected just at the time the foliage was starting to expand. It seems it is true with this, as with some other members of the family having similar habits, that the expanding of the foliage is essential to the emergence of the adults.

The injury inflicted by the species is the formation of from one to twenty aborted bud galls, usually at the twig tips, resulting in the checking of branch development, and ultimately in the stunting and malformation of the tree. In some of the most severe cases observed, 70 per cent or more of the branches were affected; in other instances

the infestation was but slight. A curious, and thus far unexplained, feature of the problem is that the pest exhibits a preference for individual trees, wherein a given specimen may be rather severely attacked, while nearby neighbors of the same species are but slightly, if at all infested. Thus far, white elm, *Ulmus americana*, only has been observed to be injured.

As previously stated, the adult has been described by Dr. Felt. The egg and pupal stages have not been observed by the writer, but larvæ may be found in abundance in the galls of infested trees from midsummer until spring. Usually more than one larva occurs within a single gall, in some instances as many as eight having been found. In two cases larvæ of different sizes, some very small and some apparently two-thirds grown, were found within the same gall. Where more larvæ than one occur, they are not separated from one another by the gall tissue but lie in a mass in the center of the gall. There is probably but one brood per season. The individual larvæ are pink or flesh in color, 3.5 mm. long and 1 mm. broad. They are typically Cecidomyid and possess the "breast bone" like organ and ability to spring into the air characteristic of many of the larvæ of this family.

Fig. 7. *Dasyneura ulmea;* typical galls slightly enlarged.

Parasitism is quite common, the adult parasites emerging through circular holes cut through the walls of the upper half of the gall. Only one species has been reared, determined by Mr. S. A. Rohwer, of the Bureau of Entomology, as *Callimome* sp. The parasites seem to be in no wise as sensitive to the drying up of the galls as do the midges,

since adults have emerged from dry material kept in the laboratory several weeks.

The future status of the insect as a pest of course cannot be forecasted, but it would seem reasonable to suppose that, on account of its apparent rather general distribution throughout southern Ohio, the creature has been present in the state for some years. This, considered in connection with the fact that heavy parasitism sometimes occurs, would tend to discourage placing it in the category of elm pests of prime importance. Nevertheless, it cannot be ignored, since individual trees are sometimes considerably stunted.

Concerning control measures, the one which seems most practicable is the cutting away of all twigs bearing aborted bud clusters before the foliage starts in the spring. As noted previously, the writer has been successful in rearing adults, only when material was collected at the time the foliage was expanding, and that the parasites emerged from material that had been cut some time. It would seem, therefore, to be the best policy to cut the twigs and leave them lie on the ground in order to allow the parasites a chance to emerge.

PRESIDENT GLENN W. HERRICK: The next paper will be presented by Mr. T. J. Headlee.

SULPHUR-ARSENICAL DUSTS AGAINST THE STRAWBERRY WEEVIL (ANTHONOMUS SIGNATUS SAY)

By THOMAS J. HEADLEE, PH.D., *Entomologist of the New Jersey Agricultural Experiment Station*

The strawberry weevil appears first to have been recognized as an injurious insect by Glover[1] in 1871 from damage done to the strawberry in Maryland. He suggested sweeping the plants with a muslin net as a means of controlling the insect. Cook[2] in 1883 suggested the use of London Purple (1 lb. to 200 gals. of water) or of crude carbolic acid and land plaster (1 lb. of acid to 50 lbs. of plaster). Riley[3] in 1885 suggested trial of kerosene emulsion and of pyrethrum mixed either with flour or water. Beckwith[4] in 1892 added white hellebore to the preceding recommendations and discounted the use of arsenicals. Chittenden, having mastered the main points in the life of the insect, summarized previous work of control and added a statement of

[1] Glover, T., Rept. U. S. Commissioner of Agric. for 1871, p. 73.
[2] Cook, A. J., 13th Rept. Sec'y. State Hort. Soc. Mich. for 1883, pp. 151–155.
[3] Riley, C. V., Rept. of U. S. Commissioner of Agric. for 1885, pp. 276–282.
[4] Beckwith, M. H., Bul. 18, Del. Agric. Expt. Station, 1892.

his own conclusions. His work is recorded in several papers, the final summary of which was presented in 1897 in Cir. 21, 2d Ser., Div. of Ent., U. S. Dept. Agric. He points out that relief may be had by: (1) Covering the beds with muslin or other similar material, (2) Cultivation of pistillate or of profusely blooming varieties, (3) The use of trap crops and clean culture. He suggests a trial of Bordeaux mixture as a repellent; the trial of Paris green and arsenate of lead, alone and combined with Bordeaux. Chittenden particularly recommends the practice of growing pistillate varieties, asserting that it has been thoroughly tested and found to be successful. Little, if any, progress in measures of control seems to have been made since the publication of Cir. 21.

For the sake of appreciating the nature of this problem of control, we should remember: that the damage is due primarily to the oviposition habits of the adult; that it consists mainly in puncturing the unopened staminate buds, laying an egg therein, and cutting the bud stalk almost off at a point some distance below the bud; that the attack begins just as the early buds begin to open and continues for a period of about two weeks; that the insect can and does use the wild strawberry, blackberry, dewberry, black-capped raspberry, common yellow flowered cinquefoil (*Potentilla canadensis*), and the red-bud tree (*Cercis canadensis*) and frequents wild flowers generally for feeding purposes.

Covering the beds with muslin or other similar material has not proven a practical measure for the larger growers. The cultivation of pistillate varieties has not proven acceptable owing to the alleged inferiority of the fruit. The cultivating of profusely blooming varieties has not proven acceptable. The use of trap crops has not met with favor because all the labor incident to them will in many years be in vain owing to a natural reduction of the beetle. Clean culture fails to meet with favor for much the same reason. The use of arsenicals and Bordeaux mixture have not yet met with success. Chittenden lists a host of so-called remedies as useless—lime, ashes, plaster, Paris green and plaster, hen manure, a mixture of tobacco dust, lime, Paris green and coal oil, pyrethrum, whale oil soap, kerosene emulsion and sweeping with an insect net.

In view of the wide range of food plants used by the strawberry weevil, any effort to prevent its work by direct destruction through clean culture and trap crops would seem doomed to failure except in districts free from woodlands and undeveloped or waste lands. If this is true, the problem of control is narrowed to one of rendering the plants distasteful or deadly during the two weeks when the damage is normally done.

Accordingly the writer in coöperation with Mr. Elwood Douglas,[1] County Agent for Atlantic County, New Jersey, set out to test various repellents and deadly substances by keeping certain plots covered with them throughout the period of danger.

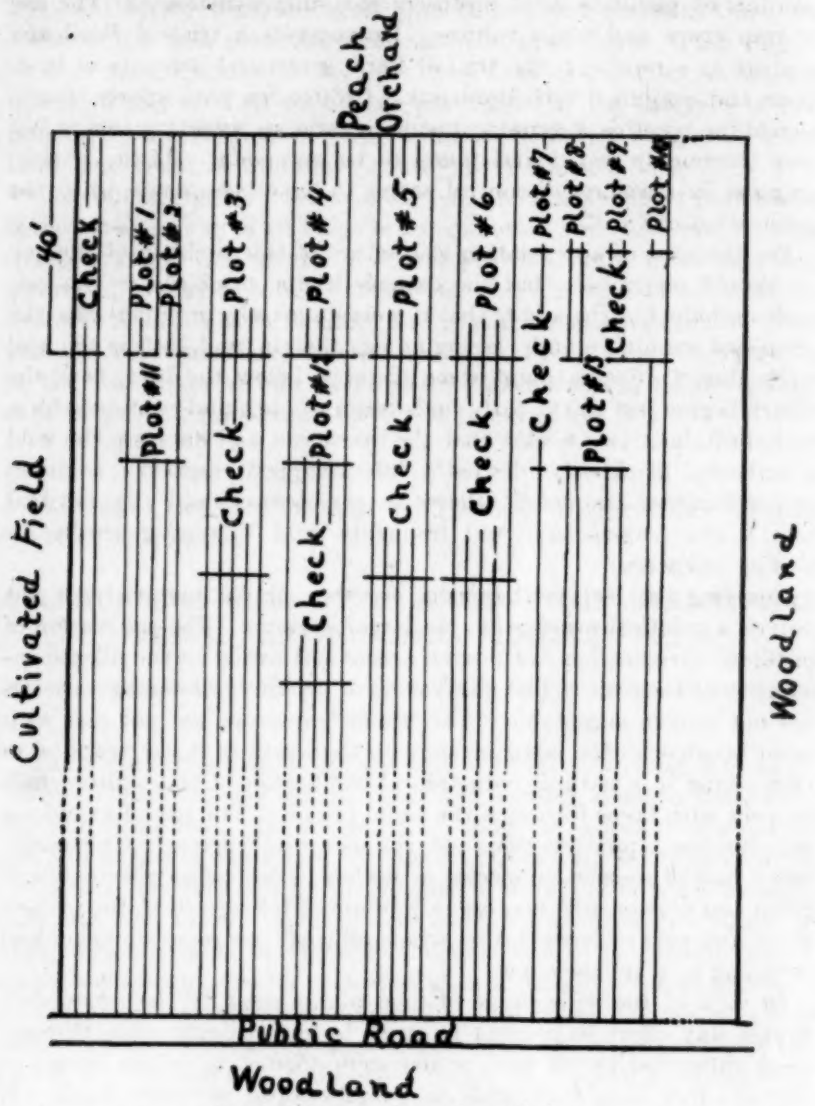

Fig. 8. Diagram of experimental plots

[1]Mr. Douglas secured the place for work, helped to make the application and to keep a record of the results.

The tests were made on a variety ("Heritage") growing on a sandy farm near Cologne, New Jersey. Woodlands of mixed pine and oak were located on the southern and western side of the field and that part farthest from them—the southeast corner—was chosen. None of the plots exceeded one eighth of a mile from the woodlands. The infestation was rather even with a noticeable increase in numbers of beetles as the woodland to the south was approached.

We resolved to try contact insecticides, stomach poisons and pure repellents. The contacts chosen were pyrethrum, whale oil soap, tobacco dust, and 40 per cent nicotine. The stomach poisons were arsenate of lead both as a powder and as a spray, a dust of arsenate of lead (1 lb.) and sulphur (1 lb.), a dust of arsenate of lead (1 lb.) and sulphur (5 lbs.), and arsenite of zinc. The pure repellents were Bordeaux mixture (5–5–50) and hydrated lime.

The arrangement of the treatments with relation to the field, each other, and the checks is shown in the preceding diagram. The treatment began when about 6 per cent of the buds had been cut—a little later than we intended. If the determinations of the buds cut showed little or no protection or that the mixture had burned the plants it was not repeated. The table which follows shows the details.

TABLE OF TREATMENTS AND RESULTS

Plot No.	Treatment		Percentage of Buds Cut		Effect on Plants
	Nature	Dates of	May 5, 1915	May 14, 1915	
	Check at beginning nothing		20	48	
1	Whale oil soap and water, 1 oz. to 1 gal.	April 30	6	52	Scorched slightly
2	Whale oil soap (10 ozs.), pyrethrum (1 lb.) and water (10 gals.)	April 27	6	42	Scorched slightly
3	Arsenate of lead (3 lbs.) and water (50 gals.)	April 28	10	25	None
4	Arsenate of lead (1 lb.) and sulphur (1 lb.) dust	April 30, May 6	7	8	None
5	Arsenate of lead (1 lb.) and sulphur (5 lbs.) dust	April 28, May 6	6	12	None
6	Home-mixed Bordeaux (5–5–50)	April 28	20	49	None
7	Tobacco dust	April 30	12	51	None
8	Powdered arsenate of lead	April 29, May 6	7	19	None
9	Powdered arsenite of zinc	April 30	Badly burned		Burned badly
10	Hydrated lime	April 30, May 6	7	41	None
11	Whale oil soap (500 ozs.), Blackleaf 40 (1 gal.) and water (500 gals.)	April 30	6	42	Scorched slightly
12	Dry pyrethrum	April 30	11	41	None
13	Pyrethrum (1 lb.), whale oil soap (10 ozs.) and water (10 gals.)	April 30	14	53	Scorched slightly
	Check at end nothing		38	60	

Limited application of the two mixtures of arsenate of lead and sulphur made on May 18, when the strawberries were in full bloom, did not apparently injure the open blossoms.

It thus appears that the powdered arsenate of lead and sulphur give the best protection—in fact, almost perfect protection. The plots treated with the arsenate of lead and sulphur when in full bloom were almost as white as snow while the untreated plots were green with here and there an occasional blossom.

The second treatments were applied when much bloom was out but none of the substances used the second time seemed to blast the blossoms.

Later in the season, a study of the cost of treating with a mixture of powdered arsenate of lead and sulphur was undertaken.

A plot 10 rds. long by 2 rds. wide was selected, containing 8 two-feet-wide rows of strawberries running lengthwise. Care was taken to coat the plots to about the same extent as had proven successful in the experiments and the half and half sulphur-lead mixture was used.

Nine and three quarters lbs. of material were used in covering this plot and 6.56 minutes were required to go over the area. At this rate the amount of material per acre is 78 lbs. and the amount of time is 52 minutes and 28 seconds. On the basis of 10 cts. a lb., which is probably the lowest figure the half and half mixture could be had for, the cost of material for the two treatments that have proven necessary would be $15.60 an acre. On the basis of the 1 to 5 mixture the cost would be about $7.30. For the sake of easy figuring let us assume that the time required for each application is one hour. The cost of labor would not exceed 40 cts. an acre.

Thus we see that the total cost for materials and labor ranges from $7.70 to $16.00 an acre. In view of the fact that, owing to heavier foliage, the amount of material used was greater than that necessary in the spring and the additional fact that practice would enable the operator to cover his territory more rapidly, it is probable that the actual cost of the application will prove much less than the figures given would lead one to expect.

PRESIDENT GLENN W. HERRICK: Is there any discussion of this paper on the strawberry weevil?

MR. WILLIAM MOORE: I was rather interested in Dr. Headlee's paper. We have been working on the strawberry weevil in Minnesota, but have obtained some opposite results. I was speaking to Dr. Headlee about this and he states that in New Jersey the weevil hibernates in woods. In Minnesota we get the weevil coming back to

the berry patch in the fall of the year or late summer and at that time they feed on the leaves of the plants.

I would like to ask Dr. Headlee a question. Did the sulphur and arsenic act as a repellent?

MR. T. J. HEADLEE: Purely as a repellent. Very few cases of destroying the weevils.

MR. WILLIAM MOORE: We find that the weevils do not feed in the spring.

PRESIDENT GLENN W. HERRICK: We will now listen to a paper by Mr. C. L. Metcalf.

THE EFFECT OF CONTACT INSECTICIDES ON THE LARVÆ OF SYRPHIDÆ

By C. L. METCALF, *Columbus, Ohio*

(Withdrawn for publication elsewhere)

PRESIDENT GLENN W. HERRICK: I am interested in the use and effect of black-leaf 40 because it is widely used in New York State for controlling aphis on apple.

SECRETARY A. F. BURGESS: I would like to ask in regard to the method of spraying in your experiment.

MR. C. L. METCALF: The tests, except one, were laboratory tests in which a small part of the twig was cut off and this twig and the aphids and larvæ present, after being sprayed with the solution, were placed in a cheese-cloth covered glass jar.

In the last experiment a section of a limb of a sycamore tree about three feet long was isolated with a band of tree tanglefoot at each end so the larva could not escape and the insecticide applied in the field.

SECRETARY A. F. BURGESS: Have these experiments been checked in the field to determine the effect of the different solutions you used? The solutions you used were no doubt weak. The contact solutions that are being used in the field at the present time have to be strong. The sample can be sprayed with a weak solution but when it comes to field applications it is more difficult to do effective work with weak solutions.

MR. C. L. METCALF: The black-leaf 40 was used at the strength recommended for destroying ordinarily resistant plant lice. In the other cases the question to be determined is whether in the long run it will be more satisfactory to use a stronger solution, thus killing aphids and larvæ; or a weaker solution which would allow the larvæ to remain and destroy any aphids not covered, and so not killed by the insecticide.

PRESIDENT GLENN W. HERRICK: I should like to ask what species of aphis were used.

MR. C. L. METCALF: The two species used were *Aphis spireacola* common on Spirea in Maine and *Longistigma caryæ* which is very common here in the lower branches of the sycamore.

PRESIDENT GLENN W. HERRICK: I want to ask you how they would compare in resistance with the green apple aphis.

MR. C. L. METCALF: The *Aphis spireacola* would be just about the same, *Longistigma caryæ* more resistant than the apple aphis.

PRESIDENT GLENN W. HERRICK: The last paper on the program will be given by Mr. W. C. O'Kane.

ARSENIC ON FRUIT AND FORAGE FOLLOWING SPRAYING

By W. C. O'KANE, *Durham, N. H.*

(Withdrawn for publication elsewhere)

PRESIDENT GLENN W. HERRICK: In answering inquiries in regard to orchard spraying I usually state that it is best to keep cattle out of the orchard after spraying until heavy rain has fallen.

SECRETARY A. F. BURGESS: I am particularly interested in these experiments because the question of injuring animals as a result of spraying often comes to our attention. In spraying work throughout the country districts that are infested with the gipsy moth, we adopt the policy of spraying where the owner agrees not to pasture his stock after the spray has been applied. In many cases this is perhaps an unnecessary precaution but it is done simply to prevent controversy or misunderstanding. These experiments, I believe, are the first definite and extensive ones that have been carried through on this particular subject and the information will be of great value to entomologists.

MR. JAMES TROOP: I want to add a bit of experience from Indiana. A number of years ago I carried on some experiments along this line in the orchard at Purdue University. The orchard was in blue grass, and the trees about twenty years old, so that the tops nearly covered the ground. During the spraying season, the superintendent of the farm insisted on letting the sheep run in the orchard. I sprayed this orchard thoroughly for three years with arsenate of lead, using as high as 3 pounds to 50 gallons of water. These trees were sprayed at three different times, each season, and the work was so thoroughly done that the grass under the trees was quite wet. The sheep fed all over this ground, but no harm to the sheep was ever noticed.

SECRETARY A. F. BURGESS: We use arsenate of lead at a strength which is greater than ordinarily used for orchard spraying, hence there might be more danger in the applications of the spray which we use. Early in the season 10 pounds to 100 gallons of water are used and the amount later is increased to 12½ pounds and occasionally to 15 pounds if the gipsy moth caterpillars are very large and it is necessary to kill them quickly. Emphasis should be placed on the necessity of keeping the spray mixture thoroughly agitated. We have encountered considerable difficulty in having the arsenate of lead properly mixed with water before it is placed in the tank. Mr. Worthley has just devised a churn which can be used to thoroughly mix the material. This is a matter which should be given attention if thorough spraying is to be done.

MR. W. C. O'KANE: Regarding arsenic left on fruit after spraying with arsenate of lead, I think I am safe in saying that you never see on apples in the market enough poison to cause the death of anyone.

Adjournment 12.00 m.

AFTERNOON SESSION

Tuesday, December 28, 1915, 1.30 p. m.

PRESIDENT GLENN W. HERRICK: The first paper on the program will be given by Mr. W. H. Goodwin.

THE CONTROL OF THE GRAPE BERRY WORM (POLYCHROSIS VITEANA CLEM.)

By W. H. GOODWIN, *Wooster, Ohio*

The grape-berry moth has been known in Ohio through its injuries for nearly fifty years. A number of entomologists have contributed to a knowledge of its life-history and habits: among them are Walsh, Riley, Slingerland, Johnson and Hammar. Several others have been engaged, at various times, in economic measures for berry moth control, but were only partially successful. Experimental work for berry worm control was carried on in 1906 to 1909 by Professor Gossard and assistants, but was finally discontinued on account of the disappearance of the serious infestation of the previous seasons.

Beginning with the seasonal life-history, the winter is passed in the pupal stage. The larva spins a silken cocoon in the fall inside a fold or flap cut out of a grape leaf. These leaves are usually flat on the ground, or they have only one edge buried in the soil, but they are always soft and moist. This seems to be the proper condition of the leaf to make it an attractive place where the larva can spin up for the

winter. These tiny pupal cases lay on the ground all winter, normally, but they break loose from the body of the leaf and are often washed some distance from the place where they spun up, by the melting of the snow and by heavy rains with a large run off of surface water. Records of several such occurrences have come to my notice and on two occasions in particular, several vineyards were practically freed from berry worm for a season by being overflowed and having all the leaves and cocoons washed away. A few of the pupæ are killed through falling into crevices in the soil of the vineyard and being buried so deeply they cannot get out again. Many of these pupæ are killed by severe freezing weather when the soil is dry and is not covered with snow. The mortality is low, however, when we have snow and wet weather throughout the winter. The extreme variations of an open winter together with dry soil may be largely responsible for the high rate of mortality. A large per cent of the specimens kept in breeding jars with moist or wet soil emerged in the fore part of June for three successive years, while others, kept under the same conditions, excepting that the soil was extremely dry, failed to emerge or the brood was represented by only 18 to 50 individuals when over 400 pupæ had been placed in the breeding cage in the preceding October.

In the latter part of the first week in June to as late as the 25th day of June in some seasons, the tiny pupæ begin to get active and wriggle or swing the rear segments back and forth. Two rows of small sharp spines on each of the abdominal segments from the second to the eighth inclusive, and one row on the ninth segment, catch in the sides of the silken wall of the cocoon and push the pupæ out of the cocoon if the struggling is continued. The front row of spines on each of these segments are larger in size, fewer in number, and do not extend more than one-third of the way around the dorsal side of the pupa, while the rows of smaller, shorter spines extend approximately half way around each of the eight segments. The swinging of the abdominal segments back and forth, sideways, and with a spiral or rotary motion makes these rows of spines catch, and every move pushes the pupa out of the cocoon. The operation takes only a few minutes' time until the pupa is about half-way out of the silken cocoon, or in case they are buried only a slight distance below the surface, they struggle until the thoracic segments of the pupa project above the surface of the soil. The pupal skin splits along the back to the first abdominal segment and the moth works out of the pupal skin, leaving almost half of the empty skin projecting out of the cocoon. The wings expand and harden in 15 minutes to half an hour, but the moth will often remain on some stick or dead leaf for several hours before it attempts to fly. If they are left undisturbed, they will sometimes remain in one place

from 8.00 or 9.00 a. m. to 2.30 or 4.00 p. m. before flying to some other position. However, they are usually able to fly in about twenty minutes after emerging. The moths seldom fly until late in the afternoon, usually becoming active about 2.30 to 4.00 p. m., and when confined in the breeding cages make frantic efforts to escape about this time of the day. When not confined, they fly to the under side of some vine or deeply shaded section of a vineyard, usually settling on the canes, where they are very inconspicuous on account of their similarity of coloration. In fact, it is only after a careful search that one can find them at all. Seemingly selecting the deep shade, the females lay most of their eggs in those portions of the vineyard where the foliage is very dense, especially when the berry worm infestation is not heavy, and the ground slopes toward the level sections having the heavy growth. Those parts of vineyards where the soil is seriously depleted and the yield of grapes is approaching a minimum, are seldom injured much by the berry worm. In many vineyards where poorly nourished, dwarfed vines carry only a small amount of foliage they are scarcely injured at all. Some vineyards, with areas of strong and weak vines, are scarcely infested on the light areas while severely injured by the berry worm on the strong, vigorous vined areas.

In northern Ohio the moths seldom emerge in numbers before the 8th to the 12th of June, varying with the season. Sometimes part of the brood emerges a few days earlier or later, but the main part of the brood usually appears from the middle to just a few days after the close of the blooming time of the standard varieties of grapes. In confinement, the moths laid some eggs from four to seven days after they emerged. A few individuals were tardy in emerging and others were equally tardy in oviposition. This makes it difficult to give exact dates for spraying, and the variation of blooming time of the grapes through seasonal variations complicates matters still more. Individuals of this brood of moths often live for ten to seventeen days, giving a long period of time for oviposition and making the application of a single poisonous spray of little apparent value. Poisons, adhering to the rapidly growing grape berries, are soon decomposed and also cover a relatively small part of the berries after ten days' time.

The larva of the grape berry worm usually feeds on the pulp of the berries. In June, a partially grown larva has often webbed together half of a developing cluster of grapes and devoured the small berries and stems, living inside of the protecting web. These webs were plentiful in some vineyards by the 25th of June and many of the larvæ were almost full grown. Large numbers of these larvæ were collected, but did not emerge as moths until the first week in August. The

larvæ are very active and often wriggle out of the grape bunch in their attempts to escape, spinning down on a silken thread unless they are violently disturbed. In the vineyard, these larvæ always spin up on the young and tender leaves of the growing grape cane. The older leaves seem to be too thick and harsh and in some way unsuitable for the forming of a cocoon near their edges. The cocoon is usually made on the edge of the thin, soft, rapidly growing leaf. In a few days the growth of the leaf will tear the tissue along the edge of the cocoon, and a few of these cocoons fall to the ground, but the larger part hang to the grape leaf by a mere shred of leaf tissue. The late individuals of this first brood of larvæ cause the rapidly growing grape berries to split open when the small larva destroys the pulp cells just below the skin of the berry. The tissue above, being cut off from a supply of nourishment, cannot grow or expand. The remainder of the berry continues to grow and the berry bursts open; sometimes it gets red on the edges of the break. The larvæ of the August brood rarely cause any bursting open of the berries. The grape berries are growing more slowly at this time and the purple spot on the side of the berry is the first visible sign of injury.

The opalescent eggs of the berry moth hatch in five to eight days and the larvæ develop rapidly in the young clusters of growing berries. Usually the earlier individuals web part of a bunch of berries together and often destroy almost half of the small cluster of grapes. Berry worms of this brood brought to Wooster from Euclid and Dover, Ohio, transformed to pupæ about the 20th to 30th of July in 1913 and 1914, but did not transform until the 1st to 7th of August in 1915. Larvæ collected from around Wooster, fifty miles further south than Euclid or Dover, transformed into pupæ almost a week earlier and the moths appeared from the 27th of July to the 2d of August in both 1913 and 1914. The main part of the brood of moths from the region of Lake Erie did not appear until the 5th to the 10th of August in 1913 and 1914, but were much later in 1915, the bulk of the brood coming August 11 to 17. In 1908, the moths of this brood were bred from material brought from East Cleveland and the greater part of them emerged during the latter part of July, ranging from the 29th to the 4th of August. From a scanty amount of Wooster material collected in July, 1909, moths appeared July 26 to 29, only a small number of moths emerging from the breeding material. The moths, emerging in the fore part of August, commence laying eggs in 3 to 5 days and continue to deposit their semi-transparent, slightly oval eggs for about 7 to 11 days. The eggs are normally glued to the sides of the berries, but they are often placed at the base of the berry stem just

where it swells in size, very close to the berry. If the brood of moths is large, eggs may be found on almost every berry. At Venice, O., in August 1915, as many as 62 eggs were found on a single bunch of 47 Catawba grape berries. One section of the vineyard averaged almost an egg to every berry on the vines. A large series of bunches were examined and the number of eggs and berries were counted. Sprayed sections of the same vineyard averaged a little less than one small worm to the bunch of grapes. In 1913, similar conditions were found at East Cleveland, and eggs were very plentiful in a number of vineyards, especially on the Catawbas. Many eggs were found in 1915 which turned dark and failed to hatch. They were readily broken, but did not seem to be parasitized, rather appearing to be infertile or else attacked by disease.

In the latter part of August and the first few days of September, small larvæ can be found in abundance, but I have been unable to find any full grown or almost mature larvæ at this time. These larvæ develop rapidly through the last week in August and the month of September. As the berries begin to ripen, the juices within the wormy berries ferment, and the berry worm larva seeks an adjoining berry, webbing the berries together as it attacks them. The juice of the abandoned berries ferments and evaporates so that a large part of those in unsprayed vineyards are only empty shells by picking time. The berries look all right from a distance of 10 or 12 feet, but close inspection reveals the fact that what ought to be grapes are nearly all mummies with only the form of the grape berries. Each full grown worm in early October averages from 4 to 9 berries which it has injured or rendered worthless.

Control Experiments

A large series of experiments for the control of the grape berry worm were performed by Prof. H. A. Gossard and J. S. Houser at Kelley's Island in 1907. The author made the larger part of the final counts and completed the season's experimental work. Various poisons and stickers or spreaders with fungicides were used on plots large enough to demonstrate their practical value. Paris green, arsenite of soda, and arsenate of lead were used in combination with Bordeaux mixture; iron sulfate mixture, with resin soap, laundry soap, and arsenate of of lead was used alone. The poisons were used at varying rates and with single and double treatments, using the fixed spars on the traction spraying machine. Spraying, directing the nozzles by hand, was also tried and compared with machine spraying. The following tables indicate the results of the various treatments.

Poison	Fungicide and Sticker	No. of Sprays	How Applied	Per cent Wormy
Paris green	Bordeaux and soap	2	Single machine	26.5
Arsenite of soda	Bordeaux and soap	2	Single machine	26
Arsenate of lead	Bordeaux and soap	2	Single machine	20.4
Paris green	Bordeaux and soap	2	Double machine	10.8
Arsenite of soda	Bordeaux and soap	2	Double machine	11.6
Arsenate of lead	Bordeaux and soap	2	Double machine	4.8

Single machine sprayings failed to give results largely because enough spray did not reach and cling to the grape bunches to be effective. These sprayings were made about June 20 to 22 and July 8 to 12. The various spreaders and stickers used with 3 pounds of arsenate of lead paste gave results as follows:

		Per cent Wormy
	Bordeaux and iron sulfate	10.18
	Bordeaux only	8.57
	Bordeaux and soap	7.9
	Bordeaux and resin soap	4.47
Hand-sprayed,	Bordeaux and laundry soap	2.9
Unsprayed		58.3

The spray was applied at a pressure of 70 to 90 pounds and double sprayed with fixed spars, excepting the hand-sprayed plot.

In 1908 similar experiments were made by the author under Professor Gossard's direction, at Euclid, O. Comparing single and double machine-sprayed plots and hand-sprayed plots, some differences are shown:

	Per cent Wormy
Single machine sprayed	21.5
Double machine sprayed	10.4
Hand-sprayed (with soap)	.71
Double machine sprayed (with soap)	4.67
Unsprayed	47.00

Arsenate of lead 3 pounds to 50 gallons of 3–6–50 Bordeaux was used in these tests with 1 pound of dissolved laundry soap as a sticker and spreader where soap was added. The spray was applied with a traction machine at 60 to 90 pounds pressure. Straight spars with the nozzles pointing at right angles to the row of grape vines were used in the machine work.

In 1907 and 1908 the applications of spray were made just before the grapes bloomed, again about June 18 to 22, and the 10th to 15th of July, when three sprayings were given.

Control measures were at first devised with the idea of reducing the size of the early broods of worms, there being supposedly three broods, thus preventing the serious attack of the last brood in the season. The large quantities of poison used was dangerous and much doubt was expressed concerning the possible deleterious effects of spray still adhering at picking time. The life-history of the berry worm was incomplete, leaving the experimenter without definite ideas of the exact time to spray and with what to spray in order to control it. The striking result obtained by Professor Gossard at Kelley's in 1907 indicated that the date of spraying should be pushed as late as was consistent with safety, but its limit was undetermined. Life-history studies have shown, however, that in the 1907 experiments the third spraying of the season was made before the first brood larvæ were half grown and many larvæ had not been hatched for more than a week. The poisonous effect of this spraying would be of little value by the 3d to 10th of August as experiments of later years have shown.

In 1909 a small vineyard at Wooster at the Ohio Agricultural Experiment Station was sprayed with dilute lime-sulfur 1 gallon in 50, with 3 pounds of arsenate of lead, and compared with arsenate of lead 3 pounds, Bordeaux 3–6–50, and 1 pound of soap. The lime sulfur practically defoliated the section treated and also destroyed the set of grapes. These were the only important results of 1909.

The grape berry worm control work was discontinued for several years on account of the difficulty in getting satisfactory coöperators, and also the partial disappearance of the berry worm.

In the fall of 1912 grape growers in the East Cleveland district appealed to the Ohio Agricultural Experiment Station for help, as the berry worm had almost destroyed their crop. A similar appeal came from the west of Cleveland District in 1913.

In 1913 experimental work for the control of the grape berry worm was begun in the vineyard of Dr. C. C. Arms at Euclid, O. The spring was cold and the grapes were slow in starting. Experimental work was based on previous experience and on the work of Johnson and Hammar at North East, Pa., given in Bulletin 116, Part II, Bureau of Entomology, U. S. D. A., and a program planned accordingly. Life-history studies had been started the fall previous as control measures depended largely on knowing the habits of *P. viteana* in northern Ohio.

The set of bunches before bloom was light, promising only a small crop of grapes for 1913. Plots were selected and a spraying made before the grapes bloomed. The plots selected were located on almost level land and each plot consisted of about two-thirds of an acre of grapes. The larger part of this section was Concords, but the plots

included some Catawbas, Delawares and a few Niagaras. A series of different sprays were used, applying the poison at different strengths, using it without and with Bordeaux (3–4–50 and 4–4–50) and also without soap, with soap, and with Bordeaux and soap in order to compare the effectiveness of the poison in different combinations. The various plots were sprayed just before the grapes bloomed June 9 to 12, just after the grapes bloomed June 18 to 21, and again on July 18 to 21. No moths had appeared at the latter date, but it was thought best not to digress too radically from previous experimental work in which good results were obtained. In the hand-sprayed plots the first and second sprayings were omitted to test the value of one thorough spraying later in the season.

The bulk of the brood of moths coming almost three weeks after the third spraying, together with the final results showing serious injury by the grape berry worm throughout the vineyard, seemed to indicate that the final spraying must be made some two or three weeks later than had been previously recommended.

The spray was applied with a power machine of large capacity and at 200 pounds pressure. The spars were of the fixed type, but the nozzles were not pointed at right angles to the grape row. The nozzles were placed comparatively low down and were angled so that the spray was thrown upward and outward as well as forward and backward, meeting the roof of the leaves edgewise instead of throwing the spray against the roof-like protecting surface of the leaves. The special spars were designed by the author, in order to completely cover the bunches of grapes with spray in a thorough manner, approaching, if possible, the best hand-spraying in covering capacity without extra labor. The ability to cover a considerable area of vineyard rapidly with a minimum expense for labor was also an important item, as directing the spray nozzles by hand adds to the cost of spraying grapes. These spars with the nozzles angled outward and upward saved the labor cost of the two men required to direct the nozzles in hand spraying. Paste arsenate of lead was used in varying amounts and in combinations with Bordeaux and soap. The results are given below with data concerning the treatment of the plots:

PLOTS AT EUCLID—1913
First Application, June 9 to 12

	Poison	Fungicide	Sticker
Plot 1	As. of Lead 3#	2–3–50 Bord.	Hard Soap 1#
" 2	" " " 3#	3–4–50 "	
" 3	" " " 4#	4–4–50 "	" " 1#
" 4	" " " 3#		" " 1#
" 5	" " " 3#	3–4–50 "	Flour in Paste 4#
" 6	" " " 3#	3–4–50 "	Hard Soap 1#

Second Application, June 18 to 21

	Poison	Fungicide	Sticker
Plot 1	As. of Lead 3#	2-3-50 Bord.	Hard Soap 1#
" 2	" " " 3#	3-4-50 "	
" 3	" " " 4#	4-4-50 "	" " 1#
" 4	" " " 3#		" " 1#
" 5	" " " 3#	3-4-50 "	Flour in Paste 4#
" 6	" " " 3#	3-4-50 "	Hard Soap 1#

Third Application, July 15 to 18

	Poison	Fungicide	Sticker	Counts Sept. 10, 11 Wormy
Plot 1	As. of Lead 4#	2-3-50 Bord.	Hard Soap 1#	26.7 %
" 2	" " " 4#	3-4-50 "		33.1 %
" 3	" " " 6#	4-4-50 "	" " 1#	19.4%
" 4	" " " 4#		" " 1#	45.7%
" 5	" " " 3#	3-3-50 "	Flour in Paste 4#	26.4%
" 6	" " " 4#	3-4-50 "	Hard Soap 1#	24.4%
			Unsprayed	84.0%

Paste Arsenate of Lead used in 1913.

In the 1913 tests, arsenate of lead was used alone, with Bordeaux, 2-3-50, 3-4-50, arsenate of lead with soap, and with Bordeaux and soap, with flour paste and Bordeaux, and a few vines were sprayed in July with arsenate of lead and gelatine for a sticker and spreader.

Arsenate of lead with Bordeaux, 2-3-50, and 1 pound of soap gave as good results as any of the other stickers and spreaders used, and was not as difficult to prepare, also it cost less than the other spreaders and stickers with the poison.

1914

The experimental work of 1914 for berry worm control was more extensive than on previous years as the members of the Dover Fruit Growers' Association coöperated with the Department of Entomology of the Ohio Agricultural Experimental Station in addition to the work at Euclid, O. In the plot work at Euclid, arsenate of lead was used at the rates of 2 pounds and 3 pounds of the dry or powdered material to each 50 gallons of spray. These amounts of poison were used with soft soap, with 2-3-50 Bordeaux, with iron sulfate Bordeaux, with Bordeaux and soft soap, and with cheap molasses as stickers or spreaders. Hand spraying was also tested in comparison with machine work. The results are listed below:

PLOTS AT EUCLID—1914

	June 8 to 10			June 24 to 27		
	Poison	Fungicide	Sticker	Poison	Fungicide	Sticker
1	As. of Lead 2#	2–3–50 Bord.	Soap 2#	2#	2–3–50 Bord.	Soap 2#
2	" " " 2#		" 2#	2#		" 2#
3	" " " 2#	2–3–50 "	(1½ gal. Molasses)	2#	2–3–50 "	(1½ gal. Molasses)
4	" " " 2#	(Bord. 2×4×50 with 4 of Iron Sulfate)	Soap 2#	2#	(Bord. 2×4×50 with 4 of Iron Sulfate)	Soap 2#
5	" " " 2#	2–3–50 Bord.	" 2#	2#	2–3–50 Bord.	" 2#
6	" Hand Sprayed	"	" "	"	"	" "
6a	" "			"	"	" "
6b	" "			"	"	

	Poison	Fungicide	Sticker	Wormy
1	As. of Lead 3#	(Nicotine Sulfate 1-1000)	2# Soap	2.14%
2	" " " 3#		2# "	7.10%
3	" " " 3#		(1½ gal. Molasses)	10.40%
4	" " " 3#	Nicotine 1-800	2# Soap	4.49%
5	" " " 3#	2–3–50 Bord.	2# "	1.98%
6	" " " 3#	"	" "	.86%
6a	" " " 3#	"	" "	2.10%
6b	" " " 3#	"	" "	1.43%
		Unsprayed		33.20%
		Neighboring Unsprayed		54.00%

Soft soap was used as it cost about half as much as hard soap.

In the various plots, arsenate of lead as the poison gave a wide range of results with the different stickers or spreaders and fungicides. Arsenate and soap and arsenate and molasses gave the highest percentages of wormy grapes of any of the sprayed plots. In plots 1, 5 and 6, very similar results were obtained but plot 6b with only one thorough spraying in the latter part of July had only 1.43% of wormy berries. In the Dover region similar results were obtained when instructions were followed and the sprayings were carefully done.

DOVER EXPERIMENTS—1914

Vineyard	Sprayed about June 8 to 11	Sprayed about June 22 to 26	Sprayed about July 30 to Aug. 5	Per cent Wormy
			As. of Lead (In one case, Bordeaux 2–3–50)	
	As. of Lead 3# Paste Bordeaux 2–3–50 Soap (soft) 2#	As. of Lead 4# Paste Bordeaux 2–3–50 Soap (soft) 2#	Syrup 1½ gal.	
*1	"	" " "	(July 23 to 30 Hand-sprayed in some sections)	3 to 7 %
*2	"	" " "	July 23 to 30	2 to 5 %
*3	"			1 to 4 %
4	"		Hand-sprayed	1 to 2.5%
5		July 8 to 15		8 to 11%
6		" 8 to 15		
7			July 22 to 31	3 to 22%
8		(No worms present)	Unsprayed	0
9			July 23 to 30	6 to 10%
10			Unsprayed	3 to 11%
11			(Sprayed about July 10)	14 to 37%
	Unsprayed			31 to 68%

* Sprayed with power machines.

In the Dover experiments each coöperator did all of the spraying in his vineyards, the author only giving directions when to make the applications and what to use.

The sprayings were made with whatever type of machine the coöperator could afford to purchase or the machine he already owned.

In some cases the applications were made at times when they were of little value, and others used inadequate and inefficient machines. The results show the value of proper spraying, as some of the coöperators who obtained the best results had the worst infestations of berry worm to fight.

Some striking results were often side by side, among them being the extremes of worminess in the berry worm control work; from full foliage to no foliage on Delawares on September 23 where the 2–3–50 Bordeaux held downy mildew in check, while arsenate of lead alone did not do so, and the fruit on the defoliated section did not ripen well. A few examples of spraying with 4–4–50 Bordeaux were found and the stunted cane growth and reduced amount of foliage were very notice-

able, especially where this strength of Bordeaux was used before and after bloom with arsenate of lead and soap.

The results obtained in 1913 and 1914 left little doubt that the spray before bloom and the one following 5 to 8 days after blooming were not of as much value as the August spraying in controlling the berry worm. In 1915 the spraying before bloom was omitted entirely except in a few badly infested vineyards. Some of the best results obtained were in vineyards which received only one thorough spraying in August with 3 pounds powdered arsenate of lead in combination with 2–3–50 Bordeaux and 2 pounds of soft soap.

EUCLID EXPERIMENTS—1915

Plot	June 29 to July 2			Aug. 4 to 7			Sept. 20
No.	As. of Lead	Sticker	Bordeaux	As. of Lead	Sticker	Bordeaux	Wormy
1	6# Paste	Soap Soft 2#	2–3–50	6# Paste	Soap 2#	2–3–50	8.6%
2	6# "	" " 2#		6# "	" 2#		14.2%
3				3# Dry	" 2#		17.4%
4				4# "	" 2#	2–3–50	9. %
5	2# Dry	" " 2#	2–3–50	4# "	" 2#	2–3–50	10.6%
6	2# "	" " 2#	2–3–50	2# "	" 2#	2–3–50	17.7%
7	2# "	" " 2#	2–3–50	2# "	No Soap	2–3–50	30. %
	Check Plot Unsprayed No. 1						81.2%
	" " " " 2						97.3%
	Averaged Unsprayed						89.2%

DOVER EXPERIMENTS—1915

	June 20 to July 9			July 26 to Aug. 13			
No.	As. of Lead	Sticker	Bordeaux	As. of Lead	Sticker	Bordeaux	Wormy
1	4# Paste	Soap 2#	2–3–50	(Same spray in latter part of July on one section)			27%
							14%
2	4# "	" 2#	2–3–50				15%
	Unsprayed Aver. No. 2						74%
				Aug. 11 to 13			
3	4# Paste	Soap 2#	2–3–50	(6# Paste	Soap 2#	2–3–50)	11%
				Aug. 4 to 7			
4	4# "	" 2#	2–3–50	(6# Paste	Soap 2#	2–3–50)	8%
5	4# "	" 2#	2–3–50				57%
6	4# "	" 2#	2–3–50				54%
7							
8	No record						37%
9	No definite records of spraying work						67%
10	Unsprayed						82%

E. L. Steuks, Sandusky, O., 1915

Sprayed August 8 to 12
As. of lead 3# Corona Dry Bordeaux 2–3–50 Soft Soap 2#
Counts October 7, 1915
Hand-sprayed August 8 to 12
Wordens 3% wormy Catawbas 2% wormy Concords 3.5% wormy
Hand-sprayed August 15 to 17
Concords 9% wormy Catawbas 10% wormy
Unsprayed
Concords 77% wormy Wordens 46% wormy Catawbas 89% wormy

The experiments for the control of the grape berry worm in 1915 were more extensive than in the years just preceding. The work was conducted in several different grape growing districts in northern Ohio in order to ascertain the practical value of the previous experimental work. Wherever the coöperators followed instructions and made the heavy application of spray carefully and thoroughly, good results were obtained, averaging less than 15 per cent wormy in the face of heavy infestations, ranging from 28 to 97 per cent wormy in unsprayed vineyards. The various coöperators who sprayed at other times, not following instructions, only confirmed the striking results obtained by spraying at the proper times. A large number of such instances have been carefully observed, although not all of the spraying was done by coöperators in the berry worm control work.

The studies of the life-history and control of the grape berry worm have included a large amount of experimental work. The moist leaves lying on the ground and upon which the berry worm spun up in the fall were gathered and destroyed on a fairly large acreage, resulting in a material reduction of the berry moth the next summer. The owner found he could pick over from one to three acres per day depending upon the condition of the vineyard.

Plowing in the latter part of May, covering those pupæ still in the vineyard, seemed to reduce the numbers of moth in June but was only partially effective.

Spraying throughout the season has been tested in comparison with one, two and three sprayings. Varying amounts of poison were used with molasses, iron sulfate and lime, soap gelatin, flour paste, nicotine sulfate and different strengths of Bordeaux mixture as spreaders or stickers and for fungus disease control. The arsenate of lead, soap, Bordeaux combination has proved the most practical, the cost and labor of preparation being less and the results obtained indicate it was more effective than other combinations.

Many kinds of sprayers and equipment were used. The power sprayers with narrow trucks and 100-gallon tank making the ma-

chine not over 7 feet long exclusive of the tongue, were the most efficient and convenient machines. The spars with the nozzles throwing the spray upward and outward were very good for the June spraying when the foliage and cane growth was not extremely heavy and the spray would reach the grape bunches.

For the August spraying the trailer method, applying the spray by hand, is more effective and economical, as it is impossible to cover every grape bunch with spray with fixed spars at this season of the year. In 1914 the spar method proved almost as good as hand applications but the wood growth was not heavy. In 1915 the wood growth was extremely heavy and hand spraying was much better than when fixed spars were used.

Nozzles are very important accessories in grape spraying. The small-capacity, short-range nozzles are of little value. Nozzles having a carrying capacity or range of 8 to 12 feet at 200 pounds pressure permit the operator to reach every grape bunch without tangling his nozzles with the grape vines. A four-foot bamboo covered rod was more convenient to use than any other length. These were used on leads of hose 40 to 60 feet long.

The vulnerable spot in the life-history of the grape berry worm, to the author appeared to be at a time just preceding the depositing of the eggs upon the berries. The moths emerging in June rarely come in a short period of less than one week, although in 1914 the bulk of the brood came in 4 to 5 days. The August brood of moths comes with a rush, almost 90 per cent of the pupæ transforming to moths in 6 or 7 days. The egg-laying period is also not so extended. In 1915 large numbers of moths placed in cages with bunches of grapes sprayed with arsenate of lead died within 2 days, while those confined with unsprayed bunches lived from 4 to 11 days. This is worthy of further investigation, as it may only happen when the moths are in confinement. No eggs were deposited in the first mentioned cage, but in the latter eggs were plentiful. In the field the first eggs could be found on the 10th of August, 1914, but could not be found until the 14th of August in 1915. On August 15, 1915, they could be readily found at Sandusky, O. West of Cleveland a few unhatched eggs were found on the grapes on August 24, 1915, but they were not plentiful. A few unhatched eggs were found on the grapes at Sandusky during the first week of September.

In the control work the best results have been obtained by the heavy applications of 4 pounds to 6 pounds of arsenate of lead paste in 50 gallons of Bordeaux with 2 pounds of soft soap, the week following the blooming of the grapes when the largest berries are about one-eighth of an inch in diameter. The second application comes between six and

seven weeks later or approximately seven weeks after the grapes bloom. This late application of spray should be heavy and thorough, covering every bunch of grapes with spray, preferably by the trailer method. Normally, in northern Ohio this spraying comes between the 3d to 12th of August and may be the only one needed.

From 80 to 200 gallons of spray per acre have been used in the various experiments. For the June spraying 100 to 120 gallons per acre applied with spars was effective, but the August spraying requires about 160 gallons per acre applied by hand. The greater amount of poison, 6 pounds paste, should also be used in this spraying. The amount of poison adhering at picking time is undoubtedly small, although considerable spray may still be visible on the bunches. During the six to nine weeks between the time of the last application of spray and the time of picking, the poison is almost wholly oxidised or dissolved and no injurious effects will result from eating these grapes. The total weight of the crop of grapes well sprayed is from two to five times as much as from similar areas of unsprayed vineyards. Several instances of even greater differences in weight of the crop at harvest time have been observed, the most unusual being about 900 pounds from an unsprayed acre and 9,700 pounds from an acre of sprayed vineyard. One-third of a ton of Concord grapes or one-fourth of a ton of Catawbas will generally cover the cost of making two thorough applications of spray. Does it pay? Is it worth while?

PRESIDENT GLENN W. HERRICK: I should like to ask, Mr. Goodwin, how many broods did you find?

MR. W. H. GOODWIN: Two broods.

PRESIDENT GLENN W. HERRICK: These accord with Johnson and Hammar?

MR. W. H. GOODWIN: Yes sir, excepting that both broods of the moths emerge earlier by ten days and I have never had any erratic or out of season broods. The hatching of the first brood of berryworms, like the emergence of the moths, is distributed over a period of four or five weeks and the worms are only partially controlled by the spraying made five to nine days after the grapes bloom. In northern Ohio most of the first brood moths emerge from the 5th to 12th of August, 90 to 95 per cent of them appearing in seven to nine days. A thorough hand spraying at this time poisons most of the worms soon after they hatch. Thus one thorough spraying destroys practically all of the second brood worms. The former recommendations provided for three applications of spray by the middle of July and were too early

to effectively poison larvæ hatching a month after the last spraying was applied.

PRESIDENT GLENN W. HERRICK: Have you found eggs of the moths appearing in the spring?

MR. W. H. GOODWIN: Yes.

PRESIDENT GLENN W. HERRICK: Where are they usually laid?

MR. W. H. GOODWIN: On the stems of the young grape cluster. The late moths of this brood deposit them on the small berries.

MR. W. C. O'KANE: One of the most interesting and valuable features of this paper is the way it illustrates and emphasizes the importance of timeliness and thoroughness in the application of a remedy. Mr. Goodwin has not used any different remedies from what have been used before, but his success is due to the way he has worked out the manner of application and the time of it.

PRESIDENT GLENN W. HERRICK: Mr. J. L. King will now present his paper.

NOTES ON THE CONTROL OF THE LESSER PEACH TREE BORER

By J. L. KING, *Cleveland, Ohio*

(Withdrawn for publication elsewhere)

PRESIDENT GLENN W. HERRICK: Is there any discussion or questions to ask Mr. King?

I was interested in one point namely, that the paper emphasized the fact that a substance effective in one territory under certain climatic conditions is sometimes of no avail in a wider territory or different climatic conditions.

I would like to ask if the asphaltum used was of the same grade as that used in California?

MR. J. L. KING: Yes sir. We wrote to the California people and bought from the same firm.

I want to emphasize the fact that had I drawn my conclusions in the fall of the same season that the asphaltum was applied, the results would not have appeared so destructive but instead I allowed the trees to remain through the winter so as to get the effect of freezing. This seems to have brought out fully the injurious effect of the asphaltum upon the bark.

PRESIDENT GLENN W. HERRICK: How was that applied? In continuous rings?

MR. J. L. KING: In some cases rings about the base of the trunk and in others over the wounded areas of the bark.

MR. E. P. FELT: I would like to ask Mr. King if he saw any evidences of the inner bark being penetrated or discolored by the asphaltum?

MR. J. L. KING: Not until late in the season did I get discoloring of the bark. When removing the bark it seemed to be very green during the first part of the season.

MR. E. P. FELT: How were the trees the spring of the next year?

MR. J. L. KING: In the following spring the bark was brown and dead under the areas which were covered with the asphaltum.

In most every case where it was applied at the base of the trees as a preventive against Sanninoidea, the trees died or were very severely injured.

PRESIDENT GLENN W. HERRICK: We will now listen to a paper by Mr. E. P. Felt.

CLIMATE AND VARIATIONS IN THE HABITS OF THE CODLING MOTH

By E. P. FELT, *Albany, N. Y.*

Climatic differences appear to exert a considerable influence upon the habits and the type of injury caused by the codling moth if conditions obtaining in New York State the past two or three years are reliable criteria. Last summer 20 per cent or more of the crop in some orchards, and in others an even larger proportion bore the characteristic blemish we have termed "side injury." This is known among New York fruit-growers as "side worm" and by many of them is supposed to be the work of the second brood of the codling moth or that of some unknown insect. Dr. Quaintance informs us that this is the so-called "sting" of western fruit-growers.

The blemish, apparently first figured and described by John W. Lloyd in 1907 (Bul. 114, Ill. Agric. Expt. Sta.), has a diameter of about one-eighth of an inch and ordinarily may be found on the smoothest and most exposed face of the apple. There is a discoloration, sometimes reddish or reddish-brown, marked by a small central slit or puncture, the point where the young apple worm enters the fruit. This injury may be easily distinguished from small scab spots and certain types of hail damage, by the characteristics given above.

Observations the past season have shown that this type of injury, hitherto almost ignored, is due to the work of codling moth larvæ hatching from late-deposited eggs—that is those laid the latter part of June or early in July. At this time the fruit has attained considerable size, being an inch or so in diameter, is much smoother than the

small apple and relatively more conspicuous. The moths seem to display a marked partiality for such fruit, and from observations in the orchard we estimated that fully 75 per cent of the eggs laid at this time were deposited upon the apples. The late-hatching codling moth larvæ appear content in many instances to eat a small, shallow, circular gallery just under the skin of the apple and with a radius of about one-sixteenth of an inch. They may then, in large measure, desert the initial point of attack and migrate to the blossom end. We have repeatedly found empty side blemishes and then located the wanderer on the surface of the apple or even in the blossom end, and in the case of sprayed trees it is by no means uncommon to find a small, dead caterpillar at the bottom of the calyx cup. The impulse to desert an apparently satisfactory shelter and brave the dangers of migration to the blossom end can hardly be explained as other than hereditary and an outcome of the same unrest which, under other conditions, leads the larva to forsake the leaf mines and search for fruit. It is perhaps unnecessary to point out that while a small mine in a leaf may amount to very little, similar damage to the fruit means serious loss.

It is noteworthy, in studying conditions in various portions of New York State, that side injury was decidedly more prevalent in the western part, especially in the vicinity of Lake Ontario, and probably in other localities where a large body of water may prevent a marked rise of evening temperatures in the spring. There is on record a statement by Cordley to the effect that eggs are not deposited when the evening temperature falls much below 60° F. In this connection some interesting data have been published by Sanderson (N. H. Agric. Expt. Sta., 19th–20th Repts., 1908, p. 406). He found that if the evenings were cool, egg-laying would sometimes be deferred for several days and stated that from June 9 to 15, 1906, he was able to secure eggs, but after that the evenings were cool until the latter part of the month and no eggs were obtained until June 28. Again, in 1907, "no eggs were found until June 22 . . . though moths had been emerging since the 10th." An examination of records made the past four years by Mr. L. F. Strickland, Nursery Inspector of the State Department of Agriculture, located in Niagara County, shows a fairly close connection between this type of injury and the rise of daily evening temperatures above 60° F., and on comparing this data with similar temperature records for inland points well removed from the influence of large bodies of water such as Wappinger Falls (near Poughkeepsie) and Chatham (near Albany) we find the records for these latter localities during the past few years to be such as to permit a fairly prompt deposition of eggs, assuming that such will

occur when evening temperatures are at 60° F. or higher. In the latter places there was comparatively little side injury. It should be stated in this connection that the daily minimum temperature is only an approximate guide, since, other things being equal, there is a greater drop in the temperature between evening and early morning inland than obtains in localities near large bodies of water. This will vary under different conditions and can only be approximated when minimum temperatures alone are available as happens to be the case in this instance. It is evident, from what we know of the crepuscular habits of the moth, that the evening temperatures are the controlling ones and here is an excellent opportunity to establish a series of records which may be of great practical value.

Every entomologist having personal experience in the control of the codling moth knows that ordinary applications of arsenical poisons can not be relied upon to destroy the young codling moth larvæ hatching from late-deposited eggs before they have injured the fruit to some extent. Consequently, in localities where these conditions obtain, thorough spraying results in almost no end wormy fruit and a comparatively small reduction in that showing the side blemish; in other words this side injury must be controlled to a considerable extent by the application of the preceding year, and here we have a very strong argument for thorough and systematic annual spraying whether the trees be fruiting or not.

PRESIDENT GLENN W. HERRICK: The paper is particularly interesting to me as showing the desirability of careful observation of old insect pests and it shows what important things may turn up as a result of these observations.

Was there any side injury from the second brood?

MR. E. P. FELT: I do not know. I am inclined to think that this serious "second brood" injury in western New York is due to late deposition of eggs.

I saw nothing that led me to believe that there was any great amount of side injury from this brood this year.

MR. JAMES TROOP: I would like to ask if Dr. Felt saw where very many or any of this first brood continued to eat into the apple until they had reached the core. We have had a good deal of trouble with this insect in Indiana during the last few years, but have found that in most cases where the larvæ started in at the side, they continued to eat into the core of the apple. I examined a great number of wormy apples and found that over 50 per cent of the larvæ of this first brood went from the side, as the larvæ were still in the apples

when the examination was made. I have noticed shallow holes that were made in the apple by the larvæ, but in most cases the larvæ were found dead in the holes, showing that they had gotten some of the poison in eating through the skin.

MR. G. D. SHAFER: Did you find any dead larvæ in these side injuries?

MR. E. P. FELT: No, I did not find any. I did not look closely for them.

PRESIDENT GLENN W. HERRICK: Had the trees been sprayed?

MR. E. P. FELT: Yes, they had been sprayed. Observations on habits of the larva hatching after late deposition of eggs was included in the experiment.

MR. G. D. SHAFER: Two years ago in Michigan I found a great many larvæ and in a few cases I was able to find dead larvæ in the little cups of the injury. I wondered if the larvæ had gotten some poison and thus succumbed to that.

MR. E. P. FELT: Lloyd records killing larvæ in that way.

PRESIDENT GLENN W. HERRICK: I will now call for a paper by Mr. S. W. Bilsing.

LIFE-HISTORY OF THE PECAN TWIG GIRDLER

By S. W. BILSING, *College Station, Texas*

INTRODUCTION

Pecan growing has become an important industry in Texas and the means of controlling the insects which affect both the tree and the nut are of great importance.

In the autumn of 1913 several of the three-year-old pecan trees in the orchard of the Horticultural Department at College Station were severely damaged by the pecan twig girdler, *Oncideres texana*. Upon close examination it was found that the damage was caused by a single female. The damage was so great that it was decided to make an investigation of the life-history of this insect.

This insect was marked by putting a drop of red ink on the right wing cover, and the methods of oviposition and egg-laying habits were closely observed. During the fall of 1913 this one female entirely severed one young tree about two feet from the ground and pruned three other trees. Every limb was pruned on two of these trees and a third was pruned almost as severely. In all, 16 limbs were severed by this single female. In each case the limbs severed were from 8 to 10 mm. in diameter. Since then we have noted individuals which cut

off limbs more than an inch in diameter. The limbs, however, are usually 7 to 10 mm. in diameter.

Food Plants

This insect is not at all choice in the selection of a tree upon which it intends to girdle limbs.

Pecan, persimmon and the various species of elm seem to be preferred to the others. Pear trees are also often severely pruned. From the observations we have made it would appear that most any kind of a plant may be selected if necessity demands it. The following is a list of trees on which the insect has been taken: Pecan, persimmon, elm, hackberry, mesquite, rose, sweet locust, water oak, post oak, live oak, hickory, maple, pear, and peach.

Egg-Laying Habits

The limb is first cut off although this habit varies to some extent and occasionally some of the eggs are deposited before the limb is entirely severed. In nearly all cases the adult stands with head downward in cutting off the limb. After severing the limb the adult begins to oviposit. The eggs are laid at the base of the leaf buds and usually one egg is deposited at a place, but this also varies and sometimes two and in rare cases 3 or 4 eggs are deposited at one leaf bud. The number of eggs deposited in a single limb varies but is usually from 8 to 12. The female is usually accompanied by the male but the girdling is done entirely by the female. Before depositing the egg she makes an incision with the mandibles at the point where the egg is to be deposited. After this incision is made some little time is taken to hollow out a place between the bark and the limb in which to place the egg. This hollowing out process is done by the ovipositor. After this is completed the egg is deposited and the opening is sealed by a black glueylike substance which is discharged from the ovipositor. Next the female makes a great number of small transverse incisions below the point where the egg is deposited with her mandibles. This is done so the bark in drying will raise like a blister and not crush the egg. During the period in which she is depositing the eggs the female often ascends to the end of the branch and begins feeding. In nearly all cases observed the female as well as the male fed entirely on the tender wood at the base of the leaf buds at the extremity of the branch. This feeding habit is not confined to the branches on which she is ovipositing but she may feed on other branches as well. The method of girdling varies but in most cases the cut is made entirely around the limb.. The limb is seldom entirely severed but a small portion of the center is left intact. The weight of the limb, especially if the tree is

still in leaf, is sufficient to break off the limb and it drops to the ground. The egg when first deposited is snowy white in appearance, is oblong in shape and from 2.5 to 3 mm. in length, averaging 2.75 mm.

Injury

When nurseries are adjacent to forests the damage may be very severe and the greater amount of damage is caused by beetles which have migrated from other trees to the pecan. Many branches are severed which would bear nuts the succeeding year. In the nursery row small trees are severed near the ground and one insect may do a surprisingly great damage in that respect. The wounds made give an opportunity for fungous diseases to enter although this damage in our observation has not been well marked. Some damage is done in checking the growth of the tree. On trees whose branches are to be used as wood for budding, the loss is very great as this is the wood which is usually severed.

Life-History

The first females begin to emerge about the 25th of August and they continue to emerge until the first of October. After turning from the pupal stage they remain in the larval burrow for from 2 to 10 days and then emerge by eating a small round hole through the limb.

From 12 to 29 days after the female emerges, oviposition commences and continues in those cases we have observed until the female dies. The number of eggs deposited varies from 50 to 207 but the average female deposits about 175. Oviposition is begun by the first females the latter part of September and continues until in December. The greatest infestation occurs from the 12th to the 20th of October. In a few cases the females have lived until the last of December but most of them die by the first of December. The first freeze kills those that have not died from natural causes.

The females live from 42 to 84 days, and the males about the same length of time.

The eggs hatch in from 17 to 30 days after they are deposited, the average time of hatching being 23 to 25 days. The larva emerges from the egg by eating its way out by means of the mandibles. It at once begins to hollow out a small cavity in the branch and keeps on feeding all winter. Several larvæ may develop in one branch. A very small number of larvæ develop in proportion to the number of eggs that are laid so one seldom finds more than three or four larvæ in a girdled twig.

The larvæ burrow in the girdled twigs until the following summer, the larval stage lasting from 288 to 328 days. Before pupating the

larvæ eat a great number of small holes through to the outside. The larval burrow is also stopped with grass before the larva pupates.

Pupation takes place during the latter part of August and the first part of September. The pupal stage lasts from 12 to 14 days, and is passed in the larval burrow.

Control Methods

The method which had been recommended in the past, that of gathering up the fallen twigs and burning them in order to kill the larvæ, is practicable where a pecan orchard is not located in the vicinity of other trees. When forests are located near a pecan orchard there is always more or less migration from other trees to pecan trees. To meet such conditions we tried out a series of experiments with arsenate of lead and found it entirely effectual.

President Glenn W. Herrick: Is there any discussion?

Mr. S. J. Hunter: I would like to ask if Mr. Bilsing noticed any tendency of the female ovipositing at the base of the minor twigs? In the case of the elm twig girdler they invariably select the base of the twigs. I also wish to ask if the twig falls after being attacked by the girdler?

Mr. S. W. Bilsing: Regarding the first question I have seen females oviposit many times at the base of minor twigs. The damage is very much less to older trees as they are not injured to any great extent because the beetles do not cut off enough limbs to be of any consequence. Most of the limbs are cut two feet from the trunks of the smaller trees, and they are usually 10 mm. in diameter. As a rule the ovipositing is done in the main twigs. Many times the twig falls after being girdled by the female and she falls with it. This is especially so in windy weather.

President Glenn W. Herrick: Never at the base?

Mr. S. W. Bilsing: Yes, sometimes they deposit eggs at the base of the twigs. Occasionally the eggs are deposited in the middle of the twig.

Mr. W. C. O'Kane: I would like to ask if Mr. Bilsing maintained check cages in his experiment where other individuals were similarly confined, but without access to sprayed material? In other words did the specimens all die because of eating poison?

Mr. S. W. Bilsing: I will say that in the experiments shown in the chart I think all of them died from the spray material. I made several experiments later in the fall but could not consider the results accurate because of the beetles in the field dying under the

same conditions, but I think all the beetles in the cage experiments died from the effects of the arsenate of lead.

MR. W. C. O'KANE: The question in my mind is whether some of the insects in your experiments may have died because they were in cages.

MR. S. W. BILSING: Where the beetles died in confinement they were in cages. Some are still in the small cages.

MR. W. C. O'KANE: How large are the cages?

MR. S. W. BILSING: We carried on the experiments in small cages which were about 18 inches high, on the life-history of the insect, and checked up these conditions with the conditions in the field.

All of the beetles that were confined in large cages were dead in 48 hours and a part of them in 16 hours.

MR. J. L. KING: I would like to ask if all these beetles were of one sex?

MR. S. W. BILSING: I used both males and females in confining them in a cage. The males died just the same as females. Perhaps the males did not feed quite as much as the females.

MR. H. A. GOSSARD: I would like to ask how the schedule for spraying pecans fits in with the schedule for destroying the case worm, the bud worm and other pecan insects; does this have to be an independent spray?

MR. S. W. BILSING: I have never done any work on the case worm but I do not believe it would fit in.

MR. C. L. METCALF: These experiments have been intensely interesting to me because of the parallelism between this species and *Oncideres cingulata* in North Carolina. I would like to ask Mr. Bilsing if he made any experiments to indicate the most favorable conditions for passing the winter? Whether he found any difference in the percentage of those that live through the winter when they were dependent on dry or moist conditions, and also how the limb was girdled when the twig sloped downward?

MR. S. W. BILSING: In answering the first question, I found in rearing material for my work, moisture had a great deal to do with the number of larvæ which survived. A small number lived over in the limbs which remained on the ground. In order to secure sufficient material it was necessary to tie a great number of these branches up to the limbs of various trees. In answering the second question I will state I have never observed any beetles girdling the branches which sloped downward.

MR. R. W. LEIBY: Have you noticed any egg parasites?

MR. S. W. BILSING: No. A considerable per cent of these insects are parasitized by a tachinid fly. I have not done a great deal of work on this but I expect to work on it in the future.

MR. C. L. METCALF: I wonder if Mr. Bilsing would care to tell us his method of keeping track of the females in order to find how many twigs they girdled.

MR. S. W. BILSING: My work along that line has not been very satisfactory. The first season I tried to keep track of these beetles by marking them with red and black ink on the wing covers. This was rather unsatisfactory. In order to determine the number of eggs deposited and the number of twigs girdled the past season, I followed up the plan of caging up some 40 insects in small cages in order to take complete notes of them. I found that the data collected in this way agreed in general with that collected in outside conditions.

MR. C. L. METCALF: Are the results on your chart all from laboratory tests?

MR. S. W. BILSING: Yes, all the data on my chart are laboratory tests.

PRESIDENT GLENN W. HERRICK: I will now call for a paper by Mr. George G. Ainslie.

NOTES ON CRAMBIDS[1]

By GEO. G. AINSLIE, *Entomological Assistant*, Cereal and Forage Insect Investigations, Bureau of Entomology, U. S. Dept. Agriculture

The Crambidæ hold much the same position economically as cutworms, jassids and aphids. Like the poor they are always with us, and, though the injury they do is usually clandestine and unobserved, it is none the less real. Everyone interested in insects is familiar with the small whitish moths which in almost every locality, at some season of the year, swarm so thickly in the grass, but the larvæ of these same moths are so successful in concealing themselves that even some entomologists with considerable field experience are unacquainted with them. Very little has been published concerning their habits or from an economic standpoint. We are convinced, however, from our field work in Tennessee and neighboring states, as well as from material and reports of damage received from field men of the Bureau in other parts of the country, that the various species belonging to this family cause widespread damage every year. Two years ago we undertook an extended study of the group and it is with the hope of stimulating interest in these insects and obtaining records from a wider area that these brief notes are presented.

In his catalog in 1902, Dr. Dyar records 79 species of the subfamily Crambinæ from North America. Since then several new species have been described, so the number now recorded from North America is

[1] Published by permission of the Secretary of Agriculture.

somewhat over one hundred. More than half of these belong to the genus Crambus. In his systematic treatment of the same group in 1896, Dr. C. H. Fernald listed and described 82 species and varieties. In that work he also briefly summarized all that had been published up to that time on the biologies of the group with the result that 62 of the 82 species have, appended to the description, this statement: "Early stages and food plant unknown." For most of the other 20 species all the information given in addition to the description of the moth is a quotation of Dr. Felt's description of the egg and first instar larva and no facts are recorded as to their habits and life-histories. Since the papers by Felt and Fernald, a few lists of species occurring in various parts of the country have appeared, but, except in the case of one or two species, nothing has been done which adds to our knowledge. The necessity for such work is unquestioned. Thirteen species have been recorded in literature or found by us feeding on and injuring some field crop aside from meadow and pasture grasses. *Chilo plejadellus*, the rice stalk-borer, *Diatræa saccharalis*, the sugar-cane borer and *Diatræa zeacolella*, the larger corn stalk-borer of the southern states, the group of three closely related and possibly synonymous species, *Crambus caliginosellus*, *zeellus* and *luteolellus*, called generally the corn and tobacco webworms, and *Crambus hortuellus*, the cranberry girdler, all belong here and in addition there must be added to the list of species known to be injurious, *Crambus mutabilis*, the striped webworm, *Crambus teterrellus*, called by the late Miss Murtfeldt the bluegrass worm, *Crambus vulgivagellus*, the vagabond Crambus, *Crambus trisectus*, the dried Crambus, and a number of others of less wide distribution. *Crambus caliginosellus* alone every year necessitates the replanting and resetting of thousands of acres of corn and tobacco in almost every state east of the Mississippi. If anyone doubts that the grass-feeding species are capable of injury they can satisfy themselves by a perusal of Lintner's account of an outbreak of *Crambus vulgivagellus* in New York State in 1881 when hundreds of acres of pasture and meadow were left so bare and brown that large numbers of cattle had to be disposed of because of lack of food for them. A somewhat similar outbreak was reported by Professor F. M. Webster from northern Ohio in 1895. On that occasion fields of young corn and oats as well as meadows were swept entirely bare by larvæ, most of them probably *Crambus trisectus* and *mutabilis*.

So far as we have been able to discover in published records, not a single individual of any species of the genus Crambus, nor, I believe, of the family Crambidæ, had been reared completely through from the egg to adult in confinement until we succeeded in doing it at Nashville last year. Dr. Felt undertook rearing experiments with some sixteen

species at Cornell in 1892–3 but did not succeed in obtaining adults. His caged material all died during the winter, and, in the light of our experience, this was probably due either to a lack or to an excess of moisture. It is very difficult to keep the larvæ so that they will neither dry out nor be attacked by fungi because of too much moisture. Even though the adults are secured from larvæ reared on potted plants, little more is learned than the total length of the combined larval and pupal life. The first year of our work we obtained many adults in this way but found we were making little progress in getting at the number and description of instars. Larvæ cannot be dug out of the earth every day or two without affecting their health. As Rev. Thos. W. Fyles wrote after he had attempted to rear some of them some years ago: "At this stage I lost my specimens—the frequent disturbances necessary to the observation of their habits proving destructive to them."

In the fall of 1914 we began to experiment with the tin salve boxes which are proving so useful in rearing many kinds of insects and soon found that they satisfied every requirement. We transfer the larvæ as soon as they hatch to a one-half-oz. box containing a moistened disk of white blotting paper and a small piece of a grass blade or other food. With a little experience one is able to regulate the moisture and food supply to the age and species of the larva, for all species do not thrive under the same conditions. No earth or sand is used in the box. Most larvæ soon make a retreat of silk and bits of grass but they can easily be driven from this for examination and will return to it as soon as the box is closed. A number of checks were run to determine if the records of the duration of the various stages obtained with these boxes were comparable with those made under outdoor conditions and they agreed almost exactly, the new generation of moths often making its appearance in the outdoor check cages on the same day that adults emerged in the boxes.

We have reared a number of species through from egg to adult in this way, and, with each individual under observation every day, it has been possible to obtain beautiful series of larvæ preserved in each instar, as well as descriptions of the same made from the living larvæ.

Not all has been smooth sailing, however, for we soon found some species whose newly hatched larvæ, however politely they were treated, refused altogether to feed on anything we could offer them. We were especially disappointed to find this to be the case with the *caliginosellus-zeellus-luteolellus* group for we had hoped by rearing series of moths with known parents to unravel the relationships of this clan. *Crambus elegans, alboclavellus* and *laqueatellus*, in addition to *caliginosellus* and *luteolellus*, have so far failed to respond to any treatment we have been

able to give them. This is the more peculiar because partly grown *caliginosellus* larvæ taken in the field are easily carried to maturity on young corn either in boxes or in cages. There is apparently some condition required by the larva in beginning to feed which we have not yet supplied. Such a case was met with in attempting to rear from the egg, larvæ of one of the burrowing webworms, *Anaphora popeanella*. The newly hatched larvæ refused fresh food but by accident it was discovered that in a box which had been thrown aside, the larvæ were feeding on partly decayed leaves and thriving. A little later in life they prefer fresh food and reject the other.

In other respects Crambid larvæ vary greatly. Some species, such as *Crambus mutabilis, teterrellus, præfectellus* and *trisectus*, continue to feed and grow as long as the weather is favorable, and, except for those larvæ which are overtaken by the winter when only partly grown, pupate as they reach their growth. They thus have several generations in a year, the exact number varying with the latitude and altitude. Others as *Crambus hortuellus, vulgivagellus, ruricolellus* and probably *laqueatellus* have one distinct generation each year and, instead of pupating when full grown, the larvæ construct their pupal cells and then spend several months in meditation.

There is enough variation in the habits of the species to make the study of this group very interesting and a knowledge of the seasonal history and habits of the particular species involved is also essential whenever it becomes necessary to formulate methods of control. We hope to develop keys based on larval characteristics so that the identity of injurious forms can be determined without waiting for the adults to emerge, which sometimes requires several months. We shall be glad to determine collected or reared species of Crambidæ for the sake of the data on geographical and seasonal distribution accompanying them.

PRESIDENT GLENN W. HERRICK: Is there any discussion of this interesting paper?

MR. E. P. FELT: I would like to ask Mr. Ainslie if he has made any serious attempt to control this grass web-worm?

MR. GEORGE G. AINSLIE: I have done nothing in this direction.

MR. E. P. FELT: We have more or less trouble in New York. I have been wondering if it might not be possible to destroy a good many of these web-worms by arsenical applications. In my studies I distinctly saw the young larva come up and cut off grass blades and

take them down into the burrow. I wonder if there would not be a time when it would be possible to destroy the larvæ of these grass web-worms. I am trying to find some place to try that out.

MR. H. A. GOSSARD: A few years ago, there was quite an outbreak in Paulding County, Ohio. Several fields of corn and oats were practically destroyed in a very short time.

I carried on a few experiments but I did not find any satisfactory means of control. The experiments made were not on very large tracts, but some were on half-acre or quarter-acre plots. The corn maggot was also present. In the same fields we tried out some of the Cooper's Apatite or soil fumigant, some iron refuse that had been used for cleansing artificial gas and tobacco dust, thinking the latter could be distributed like fertilizer when the corn was planted.

Neither the web-worms nor the seed-corn maggots were repelled from the hills, and growth of the plants was interfered with in case of all the materials except the tobacco dust. The web-worm concerned was *Crambus trisectus*.

MR. HERBERT OSBORN: The web-worm was troublesome here in Ohio last year, but not especially in the vicinity of Columbus.

My first acquaintance with these insects was nearly thirty years ago in Iowa and some of my observations were recorded in the Report of the Department of Agriculture for 1887. The moths were so abundant at that time that they caused much annoyance by flying around lights in houses.

I do not think Mr. Ainslie has exaggerated at all the damage they may do.

One point that seemed to come out distinctly was the possibility of controlling the insect where sod was to be turned into corn. Eggs were laid on grass land and with corn planted later on the same ground much injury occurred. A difference in ten days in plowing determined whether the corn was destroyed or not.

PRESIDENT GLENN W. HERRICK: I was very much interested in Mr. Ainslie's methods of breeding the insects.

It agrees with some experiences we have had in rearing the clover leaf weevil. They seemed to deposit eggs and get along better when kept in the small salve boxes than when we put them in a large cage with clover plants.

I think this is a very interesting piece of work and I hope Mr. Ainslie will keep it up.

If there is no more discussion of this paper we will pass to the next one by Mr. Wm. P. Hayes.

A STUDY OF THE LIFE-HISTORY OF THE MAIZE BILL-BUG[1]

By WM. P. HAYES, *Assistant Entomologist, Kansas State Agricultural Experiment Station*

The maize bill-bug (*Sphenophorus maidis* Chittn.), a rhyncophorous beetle belonging to the family Calandridæ, is commonly known in localities where it does injury to corn as the "elephant bug" or "corn bill-bug." Reports of damage by this insect in Kansas date back twenty years (1895). Although the species has been taken as far north as the Kansas River, its injury to corn has been confined almost entirely to the fertile river valleys in the southern part of the state.

Previous to 1905, when Chittenden described *Sphenophorus maidis* as a distinct species, the ravages of this insect were attributed to *Sphenophorus robustus* Horn and *Sphenophorus pertinax* Oliv., particularly the former. Thus the earlier references to this insect have been confused with these two closely allied species. The earliest records of this pest, in the Department of Entomology of the Kansas Agricultural College, date back to 1896–97 when, under the name of "elephant bug," it was reported doing damage to corn on Wild Cat Creek, eighteen miles east of Eldorado. Kelly (1911, Bul. 95, Bu. Ent., U. S. Dept. Agr.), however, reports it one year earlier from three localities in Kansas.

During the seasons of 1914 and 1915, the writer was detailed in southern Kansas to study this and other injurious insects of that region. The results obtained during that time are herewith set forth.

DISTRIBUTION

Sphenophorus maidis has been recorded from the following places: Alabama, Georgia, South Carolina, Texas, Michigan, Oklahoma, Arkansas, and the following places in Kansas: Augusta, Madero, Florence, and Riley County. Two specimens were found in the entomological collection of the Kansas Agricultural College, one labeled "Topeka, August 11, 1911," and another labeled "Wichita" with no further data. From these scattered reports there seems to be no doubt that it is distributed over most all of the southern states.

Since the study of this form was taken up, *Sphenophorus maidis* has been taken in the following places in the state: Winfield, Arkansas

[1] Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 15. This paper embodies the results of some of the investigations undertaken by the author in the prosecution of project No. 92 of the Experiment Station.

City, Hackney, Dexter, Rock, Kellogg, Leon, Marion, Peabody, and Greenwood County.

The bill-bug is found principally along river bottoms, where its greatest damage to corn is done. It is also found doing slight injury on the second bottom land and rarely on upland. In neither case is the damage appreciable compared to the lowland ravages. In lowlands, preference is also shown to plants on heavy gumbo soils, corn on sandy soils being not so seriously injured.

Means of Dispersal

The rate of dispersal of the maize bill-bug under natural conditions must necessarily be slow, for, although wings are present under the elytra, the insect was not once observed during the two seasons to attempt flight. Because of this fact, adults were easily kept all summer in open Mason jars.

Floods are probably a small factor of dispersion. During the 1915 season, three adults were observed being carried by the high waters but, as a rule, during floods they burrow into the soil and are unaffected. Adults can live for many hours in water. Mr. J. C. Delaney reports an uninfested field some years ago becoming infested after a heavy rain from water coming from a higher, infested field. Driftwood may play an unimportant part in their spread.

In two southern Kansas counties, two theories are held to account for the introduction of the "elephant bug." In Greenwood County, the farmers along Wild Cat Creek are positive that a Mr. Chain introduced them from Texas with cattle bedding about 1896. In Cowley County on Grouse Creek, a Mr. Barney Ish is accused of introducing them in the same manner.

Character of Injury

The corn plant is subject to damage from both the adult and larva. Feeding punctures of the adult kill a large number of young plants soon after they break through the ground. The punctured plants do not show much damage externally but closer examination reveals large cavities gouged out beneath the narrow, slit-like opening. These punctures, if made in a curled leaf, will cause it, when unrolled, to show rows of holes similar to the damage done by the smaller bill-bugs. These feeding holes are made either just below or above the surface of the ground. Sometimes they are made in the germinating seed and even in the tender roots. This feeding generally causes the plant to become twisted and distorted and many are killed outright. Similar punctures were observed in cane and kafir, both in the field and laboratory. In rearing cages, punctures were likewise made in feterita

and sweet corn when no other food was available. Young plants are often slightly injured by adults clasping their feet around the stalk and piercing the epidermis, making six rather deep holes.

Plants that survive or escape injury from the feeding of the adult are subject to damage from larval feeding. While oviposition punctures may not seriously harm the plant, yet the resultant larva begins its damage by burrowing up or down from this point. If it begins to work up it will finally turn and work towards the tap-root. The larva, burrowing the stalk, does not always kill the plant, but causes the upper leaves to take on a wilted appearance and the whole plant becomes distorted. Infested stalks seldom bear ears but do produce numerous suckers.

Food Plants

Larvæ were not only successfully reared in maize, but also in cane, kafir, sweet corn, and feterita. Adults likewise fed on these same plants when confined in cages without other food. In the field, they were found feeding on kafir and cane that had been planted on infested corn land. In the spring of 1915, dead larvæ and pupæ were found in kafir stubs. A single adult was found by the author feeding on one of the rosin plants (*Silphium integrifolium* Michx.) and one writer found all stages, except the egg, of this insect in swamp grass (*Tripsacum dactyloides* Linn.). Continued search in this grass at Winfield, Kansas, failed to reveal any trace of them even alongside of infested fields.

Adult

Upon shedding the pupal skin, the adult is light brown in color, varying from red to a whitish-yellow in the body sutures and striæ of the elytra, but after two or three days they become thoroughly pigmented, assuming a reddish-black color.

In 1914, mature bugs were found in the field as early as July 29, while in 1915, none were found until September 2. However, in rearing cages in an outdoor insectary, they began to appear August 16. This difference in time of appearance in 1914 and 1915 is undoubtedly due to climatic conditions, the former being a hot, dry year, while the latter was unusually cold and wet. Other differences to be mentioned later, such as variation in length of egg, larval and pupal stages, can probably be attributed to this same cause.

In the fall, after becoming adults, many bugs emerge from their pupal cells by gnawing their way out through the lower end of the corn stalk, and it is claimed, but not corroborated, that they pass the winter in the soil. Adults were kept alive for over a month in soil where they often formed cells by compacting the earth around them. The majority of adults, however, pass the winter in pupal cells con-

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Maize bill-bug: 1, Infested roots and pupa in burrow; 2, Plants showing injured root system

1 2

Maize bill-bug: 1, Dwarfed corn plants bearing ear near surface of ground (one characteristic of bill-bug damage); 2, Feeding position of adults.

structed in the stalk. When corn fields are plowed in the spring their winter quarters are broken up and they seek shelter under old corn shocks, trash, or anything offering favorable protection. About the last of April, they begin to emerge from these temporary shelters and seek food wherever it is available. Corn coming through the ground at this time is severely injured by the bill-bugs moving from plant to plant.

Mating begins in the early part of May after the bill-bugs have fed for some time. In 1914, it was observed as early as May 10. Thirteen days later the first eggs were found. Mating may occur either on the plant or on the surface of the soil at any time of the day, but seemingly more often in the morning. A single pair was observed to mate twelve times between May 11 and July 7, but as they were not under constant observation, mating may have occurred more frequently.

Chittenden (Proc. Ent. Soc. Wash., vol. 7, No. 1, pp. 59–61, 1905) gives the following sexual differences which readily distinguish males and females: "♂—first abdominal segment very feebly concave; pygidium truncate at apex. ♀—first ventral segment scarcely different; pygidium narrowed and rounded at apex."

Overwintering adults may live through the summer and into the fall as late as November 3, but the majority die soon after the egg-laying period ends, which is from the last of June to the first of August, depending on the character of the season.

Adults can be easily reared in any cage with smooth perpendicular sides, such as tin or glass, that will prevent them from climbing out. Mason jars, empty cigar tins, or large, covered mailing tubes are always obtainable and satisfactory.

Egg

Eggs are deposited in slits made by the female in the plants either just below or above the surface of the soil. Generally these slits are made in the sheath surrounding the stalk and do not seriously affect the plant. The slits are made with the beak of the adult which afterwards reverses its position and deposits the egg. Upon the withdrawal of the ovipositor the slit closes. These punctures are small compared to the feeding punctures, containing ordinarily only one egg in a slit. However, as many as three eggs have been found in a single cavity. Eggs are sometimes laid in the soil near corn plants and may be laid, even when corn is available, in the bottom of rearing cages that do not contain soil. Generally, these larvæ, upon hatching, fail to find food and perish.

Eggs are yellowish-white in color, reniform in shape, and about three millimeters long. The average length of the incubation period

varied considerably in the two years under observation. The following table shows the variation:

Date	Incubation Period: No. Eggs Hatching	Min. Days	Max. Days	Aver. Days	Remarks
1914	110	4	25	8.2	Dry season
1915	506	5	39	12.26	Wet season

A single female was observed to lay 59 eggs, the average for 41 females for an entire summer being 22.9.

Egg-laying begins about the latter part of May and continues, in late seasons, until the first week of August. Individual females will lay eggs, intermittently, over a period of 68 days. Eggs are, as a rule, not laid daily by individual females. Frequently, they are deposited for two or three consecutive days followed by an intermission of a few days. Six per day was the largest number of eggs to be laid by a single individual.

Eggs require moisture, for hatching, which is furnished by the tissues of the plant. Eggs kept on damp soil hatched readily. Under laboratory conditions they were easily incubated in moist vials or on freshly cut pieces of corn stalk.

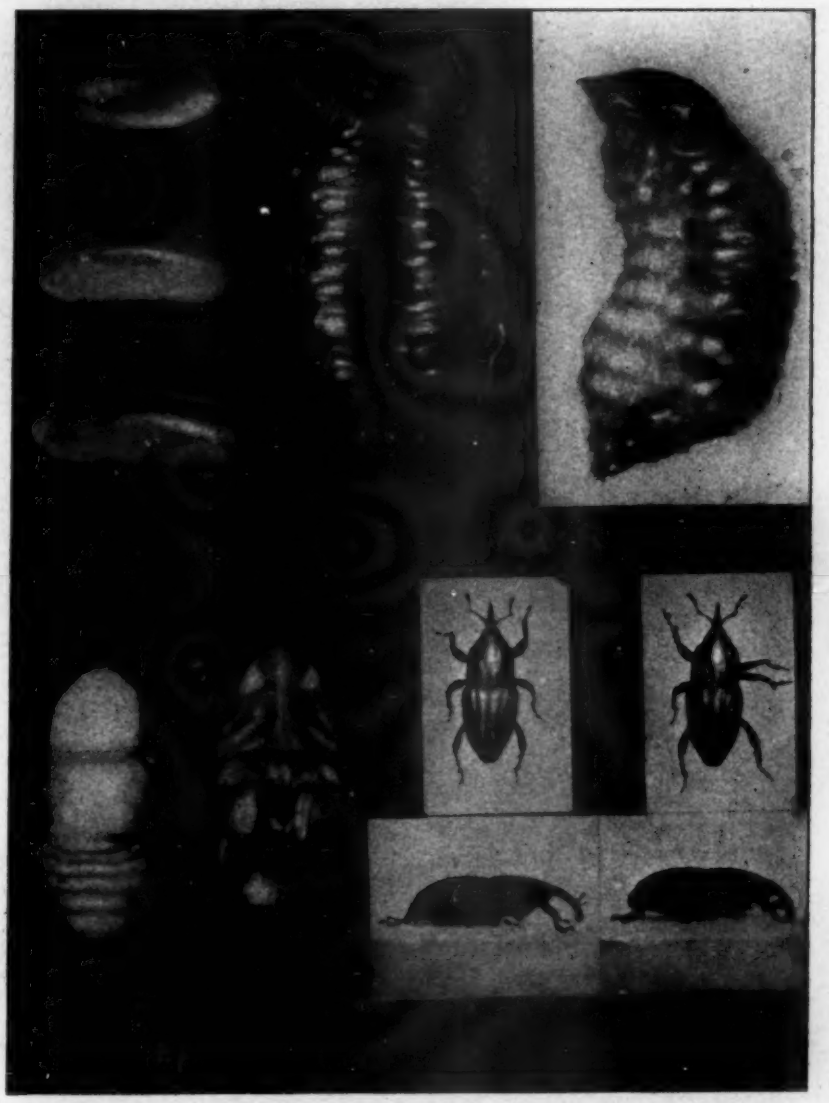
Fully developed eggs dissected from recently killed adults always failed to hatch. These females, at the height of the egg-laying period, were never found to contain more than six ripe and three immature eggs at one time.

A few days before hatching, body segments of the growing larva can be seen through the shell. Frequently, the brown coloration of the head is noticed, especially in late hatching eggs.

Larva

In hatching, the egg splits at the end containing the caudal region of the larva and along one side. By continued twisting, the young, footless larva backs its way out and finds itself surrounded by an abundance of food. At this time it is scarcely larger than the egg and is white in color, except the head which is a chestnut brown. Frequently larvæ, hatching after a short incubation period, are white with only the mandibles of a brown hue. In the latter case, the whole head completely darkens soon after emerging from the shell.

The young larva at once begins to work up and down in the stalk, leaving the burrow behind it filled with castings. Before pupation, part of these castings are used to construct a pupal cell by compacting them against the walls of the burrow near the tap-root. The larva, if head downward, reverses its position, assumes a quiescent stage for two or three days, undergoes a final moult and pupates. This insect was observed to moult five times. Three or four larvæ may work in



Maize bill-bug, various stages

independent burrows in the same plant, a condition often found in badly infested fields. Adults, pupæ, and larvæ may frequently be found in a single stalk.

After becoming established in a stalk of any size, they were never observed to burrow through the tough, outer covering of the plant above ground, but may do so occasionally beneath the surface.

The length of the larval stage varies considerably. In 1914, on corn, it ranged from 40 to 60 days with an average of 52.5 days. The following table shows the length of the larval stage in 1915 on different food plants:

LENGTH OF LARVAL STAGE

Food	No. Attempted to rear	No. Matured	Max. Days	Min. Days	Aver. Days
Maize	337	141	69	32	42.83
Kafir	47	6	68	32	47.50
Cane	46	12	75	39	54.83
Feterita	34	7	52	38	44.42
Sweet Corn	13	3	56	43	48.00

In 1915, the average length of the larval stage, on maize, was reduced from 52.5 to 42.83 days, almost ten days in a much cooler season. The minimum was also lowered from 40 to 32 and the maximum raised from 60 to 69 days. These results were obtained in an outdoor insectary and checked closely with field observations. One larva, feeding on cane, was kept alive 123 days, but died before pupation.

Although larvæ were found at work in the fields as early as June 6 in 1914, they were not found until July 1 in 1915 and were present thereafter throughout July, August, and part of September.

PUPA

Pupation occurs in the pupal cells constructed in, or near, the taproot of the infested plant. Pupæ are generally found in the upright position which the larvæ assume just before transformation. At first, they are creamy-white, but in from 4 to 6 days they begin to gradually darken until they are nearly the color of new adults.

The pupal, like the egg and larval stages, varied considerably in the two seasons under observation.

LENGTH OF PUPAL STAGE

Year	No. to Pupate	Max. Days	Min. Days	Aver. Days	Remarks
1914	11	13	10	11.4	Dry season
1915	114	30	9	13.84	Wet season

SEASONAL HISTORY

There is but one generation annually. Adults that have lived through the winter will sometimes be abroad after their progeny are matured.

The following unsuccessful attempt was made to get a second generation or at least a partial brood. Three sets of males and three of females that had matured since August were placed in cold storage in September. One set was left one week, the second two weeks, and the third three weeks, at a temperature varying from −4°F. to +12°F. These were then removed to a greenhouse and the males and females put together and given summer conditions. No mating occurred and all adults soon died. A check, run under natural conditions, also failed to produce a second generation.

Concerning hibernation, more work is necessary. A large majority pass the winter in their pupal cells, but those leaving the stalks in late summer and early fall must be accounted for before winter methods of control can be thoroughly successful.

Summing up the seasonal appearance of this bill-bug, we find the adults present in fields throughout the fall, winter, and larger part of summer, eggs in May, June, and sometimes July, larvæ from the first part of June to the middle of September, while the pupæ are present from the latter half of July to the last of September.

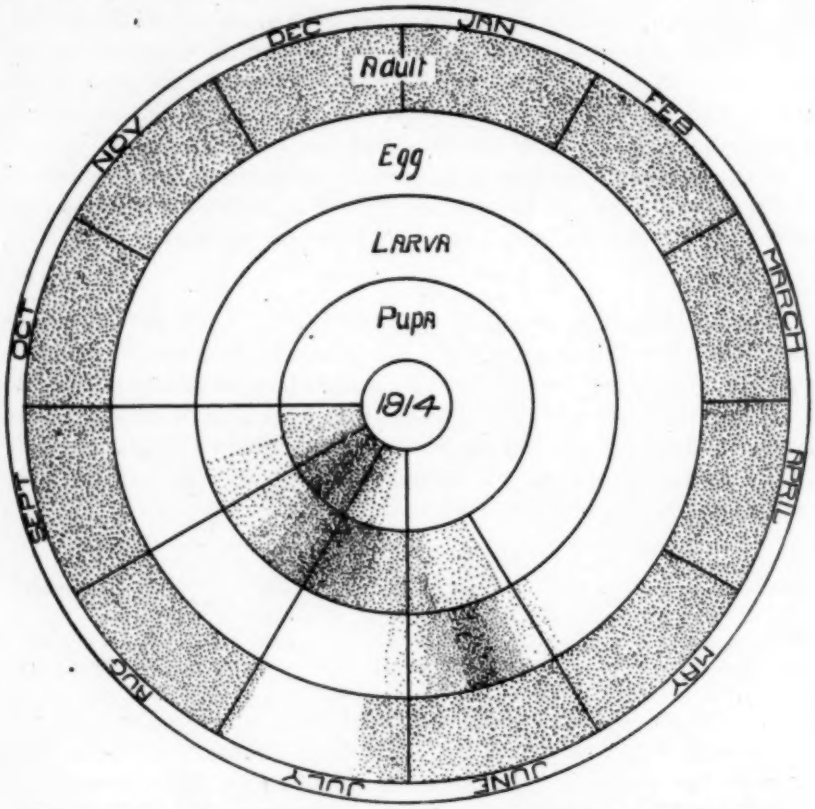


Fig. 9. Diagram representing the seasonal appearance of the maize bill-bug

Natural Enemies

Unfortunately, this insect apparently has few natural enemies since, to date, none have been recorded. This scarcity may, in part, be attributed to the protection which is afforded by its habit of living, the greater part of the year, in the corn plant.

Near the close of the 1915 egg-laying season, four dipterous larvæ were found living in a single egg, the only instance of apparent parasitism to come under observation. The Diptera were not bred out but it is the intention to further investigate this parasite during the coming season.

Predaceous enemies often gain entrance to the larval burrows, especially when the tap-root rots in the soil. Chief among these are carabids, elaterids, and ants. The following is a list of enemies found attacking the different stages:

Attacking egg—
- Parasitic
  - Unknown Diptera

Attacking larva—
- Predaceous
  - Carabidæ—adults and larvæ
  - House ant (*Monomorium pharaonis* Linn.)
  - Little thief ant (*Solenopsis molesta* Say)

Attacking pupa—
- Predaceous
  - Elateridæ—larvæ
  - Corn field ant (*Lasius niger americana* Emery)
  - House ant (*Monomorium pharaonis* Linn.)
  - Little thief ant (*Solenopsis molesta* Say)

Attacking adult—
- Predaceous
  - Carabidæ—adults
  - Little thief ant (*Solenopsis molesta* Say)

Control Measures

The cheapest, most satisfactory, and practical method of control is the use of a cropping system in which corn does not follow corn. It should be succeeded by some crop that is not subject to injury by this pest. In southern Kansas the best general practice has been found to keep the infested fields in alfalfa for a few years after which corn may be safely planted.

The pulling up and burning of stubble has hitherto been recommended as an efficient remedy in controlling this species. This is a very laborious and impractical task on a 60- or 80-acre field and is not very

effective because many beetles leave the tap-root in early fall and, as yet, their winter quarters are not definitely known. Moreover, infested plants break off easily when pulled out and often, even when the greatest of care is exercised, beetles are left in the lower part of the tap-root.

Swamp grass in and around infested fields should be destroyed as well as volunteer corn or sorghums. As in the control of many other insects, weeds, rubbish, and trash should be cleaned up to destroy hibernation quarters.

PRESIDENT GLENN W. HERRICK: Any discussion of this paper on the maize bill bug by Mr. Hayes?

MR. WILLIAM MOORE: I would like to ask Mr. Hayes if he ever tried cutting stalks off quite low, if there was any difference in the successful hibernation of the insects?

MR. WILLIAM P. HAYES: In fact it is the best way to get a supply of beetles, to pull up the roots in the spring.

MR. WILLIAM MOORE: The reason I ask is that in South Africa an insect hibernating under similar conditions can be controlled if the stalks are cut low. They freeze out when the weather is 15 or 20 degrees above zero.

PRESIDENT GLENN W. HERRICK: Moths or beetles?

MR. WILLIAM MOORE: Moths, *Secamia fusca*.

MR. A. H. BEYER: In my observations in the south in one field in particular where the stalks were cut low and lots of trash had accumulated, I did not find any change. They hibernated as well in the fields adjacent.

MR. Z. P. METCALF: There is one thing that I would like to say about a nearly related species (*Sphenophorus callosus* Oliv.) that we have in North Carolina. In the fall of the year all the adults evidence a desire to take to flight; at no other time of the year have we noticed any attempt on the part of the Southern corn bill bug to fly, in fact earlier in the season our mated pairs have frequently been left in open cages for days at a time and the beetles made no efforts to escape. This, together with the fact that the adults seem to disappear from the fields very suddenly, leads us to believe that there might be a fall dispersal flight but so far all our efforts to demonstrate such a flight have been without success.

I would like to ask Mr. Hayes if he has observed any such flight, for although our evidence is purely circumstantial it seems to point in that general direction and I thought that perhaps someone else had been more successful in making these observations than I have.

MR. WILLIAM HAYES: I have had no experience in that line but I thought it was mice that carried off the missing bugs. I have always kept them in open cages. I do recall one instance sometime in the fall that I wondered at the disappearance of several bugs out of a certain cage. It is possible they might have flown away.

MR. Z. P. METCALF: I do not attribute the sudden disappearance of the Southern corn bill bug from our open cages to the work of mice for I actually saw them fly away.

MR. F. M. WEBSTER: I would like to ask if anybody has any proof of their leaving the field at all. Where corn follows corn, if you alternate by a crop of cotton, no difficulty results with the next crop. One of these species was worked over and published by the Bureau of Entomology. I believe where corn has followed corn for two or three years, a rotation of crops, except of kafir or something of that sort, is necessary.

MR. Z. P. METCALF: In our experience in North Carolina we have not been able to find any constant differences where corn follows corn or where corn follows cotton. As a general principle the corn bill bug is worse where corn follows corn but this is not always the case. And from our experience it is not safe to recommend crop rotation as the only remedy necessary for the control of the Southern corn bill bug. I have in mind now a field of considerable elevation where the corn bill bug was worse, although the field was in cotton the year previous, than it was in an adjoining field of lower elevation and hence more likely to be attacked by bill bugs that had been in corn the year previous. This same condition has been noted in various localities and I would like to ask Professor Webster, therefore, if there was not some other factor of more importance than crop rotation involved in the field of corn on the "Shannon house place" which is illustrated in his bulletin on the "Curlew bug." A heavy application of fertilizer will make corn grow very rapidly and escape the attack of the corn bill bug. And in the past cotton farmers have been in the habit in North Carolina, at least, of making heavy applications of fertilizer to cotton and none or only a very light application to corn. A great deal of this fertilizer might be held over in the soil until the following year when it would make its presence felt on the corn crop. Time of planting is also a very important factor in the control of the corn bill bug. Either one of these factors might account for the fact that one could tell to the very row which part of the field had been in cotton the year previous and which part had been in corn but from a pretty extended study of this insect in the field, it is hard for me to believe that there would be anything in the mere fact that the field had been in cotton the year previous to prevent the corn bill bug from attacking the corn.

MR. F. M. WEBSTER: I do not think any fertilizer was used at all. There might be a difference between the low land and the high land in North Carolina.

MR. Z. P. METCALF: The reason I mentioned the fact that the field in which corn followed cotton was a field of considerable elevation whereas the field in which corn followed corn was much lower, was because all other things being equal corn bill bug injury is much worse in low fields than it is in high fields, yet here was a case the exact reverse of this. I do not wish to leave the impression that crop rotation is not of some benefit in our fight against the corn bill bug. What I wanted to say was that I can see no reason why the corn bill bug should not spread to fields that had been in cotton the year previous. At least I can see no reason why the corn bill bug should stop in adjoining fields at the very row where the cotton field commenced, unless there was some other factor, such as time of planting or kind of fertilization involved.

MR. H. A. GOSSARD: I would like to ask if any of these gentlemen can tell me if there is any evidence that stirring or cultivating the infested land has any effect on the insects; by being disturbed they might be excited to flight and leave the field? A few Ohio farmers have written me that by very industriously cultivating the corn at the time of attack, the attack ceased.

MR. Z. P. METCALF: We have tried thorough cultivation in the same plot with practically no cultivation and while corn does not grow as well where it is not cultivated yet it was impossible to notice any very great difference in the amount of injury between the cultivated plot and the uncultivated plot.

MR. WILLIAM HAYES: I know of a field where the corn was burned in early spring. I found bugs in the stumps after the fire had passed over them.

MR. S. J. HUNTER: As I see it, Mr. Hayes has placed the emphasis on the right point; viz., rotation of crops.

In the case of the Diabroticas in corn it has been our experience that no serious injury occurs until after corn has been planted in the same ground for three years or more.

PRESIDENT GLENN W. HERRICK: We will now have the next paper by Mr. Schoene.

THE ECONOMIC STATUS OF THE SEED-CORN MAGGOT (PEGOMYA FUSCICEPS ZETT.)[1]

By W. J. SCHOENE, *Blacksburg, Va.*

This insect is known as the seed-corn maggot, though it is said to injure sprouting beans and peas, seed potatoes, and the roots of cabbages and onions. The early history of the species has been fully treated by Slingerland,[2] Chittenden[3] and others. *P. fusciceps* attracted much attention during our study of the cabbage maggot and at times it was difficult to tell from collections of adults which was the more important species. There have been some specimens of *fusciceps* in practically all our collections of adults of *P. brassicæ*, the numbers varying with the season and the location where the flies were captured. In one experiment in which the adults of *brassicæ* were collected as they emerged from a badly injured cabbage seed-bed[4] the males of this species constituted 23 per cent of the total number of males. In sweepings of pea-fields or wild mustard, males of *fusciceps* were frequently more numerous than those of the associated species.

Because of the uncertainty of the part played by this insect, some efforts were made to ascertain its habits and to find its other hosts. To that end many large fields of peas, beans and potatoes in Ontario county, New York, were examined for injured plants. However, very few infested plants were found and for a period of eight years only a few cases of injury were ever reported from that region, though peas, beans and potatoes are among the principal crops. In spite of our efforts, the importance of the insect was a matter of some doubt until the following observations were made.

During the autumn of 1911 a number of examinations of the crop remnants of a cabbage field were made to secure material for breeding experiments. The field in question contained a large number of sprouted cabbage heads; that is, heads that had ripened and then because of abundant moisture had put forth new growth. These heads contained terminal sprouts eight to fifteen inches high. After the head is broken it is no longer marketable, so these had been left in the field after the crop was harvested and many of them had become infested with maggots. Apparently the eggs had been deposited

[1] Contribution from the Department of Entomology of the New York State Experiment Station, Geneva, N. Y.

[2] Cornell Agr. Exp. Sta. Bul. 78, p. 499.

[3] U. S. D. A. Ent. Bul. 33, p. 84.

[4] Jour. Eco. Ent. 4: 210.

at the point where the sprout had broken through the head. These sprouted cabbages were in various stages of decay. Some of the decayed parts of such plants contained a number of *fusciceps* larvæ, while heads that were not decayed contained no *fusciceps* larvæ, although more or less infested with larvæ of *brassicæ*. These conditions suggested that the laceration of the plants by the larvæ of *brassicæ* and the development of areas of decaying tissue had made the heads attractive to *fusciceps*. In all our examinations of material in which *brassicæ* larvæ were breeding there has been every indication that this species prefers sound tissue. This fact, when considered in connection with the well-known range of food materials of this species, has led us to believe strongly that at least in this instance *fusciceps* was largely a secondary pest of the cabbage, attacking the plants only after rotten tissues developed.

However, in going over some of the accounts of the work of *P. fusciceps* it is evident that some entomologists have believed the insect to be capable of causing injuries to growing crops. Chittenden[1] states that "the seed-corn maggot was observed during April and May doing great damage to late planted beans in the vicinity of Diamond Springs, Va. In certain areas rows were entirely killed off, necessitating replanting." Also, "during the spring of 1909 extensive injury to seed potatoes was incurred in Tidewater, Virginia."

Although *P. fusciceps* has been reported as injurious many times there are a few writers who have suggested that cool, wet weather has something to do with the appearance of the insect in sprouting seed. Fletcher[2] says, "Corn sown during a cold, wet period by which germination is unduly delayed is very liable to be attacked by the corn-seed maggot." During 1910 the farmers in certain sections of the central west became much alarmed because large areas planted to corn failed to germinate and upon examination found the seed to be infested with small worms. Regarding the outbreak, Dr. Forbes[3] makes the following statement: "The insect injury is due to two insects, called respectively, the black-headed grass maggot and the seed-corn maggot, both of which are particularly liable to infest seed corn which has been in the ground a long time, either dead and decaying, or softened and possibly sprouting, but delayed in growing. Injuries by these insects are at present, I think, not so serious as they seem, the main damage being done by the weather."

In conclusion, there are positive indications that the insect does occasionaly feed upon partially decayed matter, but we have no

[1] Va. Truck Exp. Sta. (Norfolk) Bul. 2, p. 34.
[2] Central Exp. Farms Ottawa Bul. 52, p. 35–36.
[3] Ohio Farmer, p. 702, 1910.

evidence to show that it will not also feed upon healthy plant or animal tissue. It is believed that if entomologists would study the conditions favoring the development of large numbers of *P. fusciceps*, its economic status would soon be determined.

MR. J. M. ALDRICH: Recently in Michigan I had a conversation with Professor Pettit, and he told me that this fly is very injurious to beans in that state, destroying the young plants. I also heard the same complaint about its habits in Canada, when I was lately at Ottawa. It seems to be very important.

MR. T. H. PARKS: In regard to the injury this insect does to beans, I wish to add a little to what Dr. Aldrich has said. In southern Idaho during the spring of 1914 *Pegomyia fusciceps* appeared in wholesale numbers in bean fields, the maggots attacking the sprouting beans after the young plants had developed the second leaf. Inasmuch as the young plants were soon killed, there was certainly circumstantial evidence that the maggots were attacking the living plant beneath the surface, and also the sprouting seed. The injury extended over several large areas ranging in altitude from 2,800 to 4,500 feet, and in some cases the crop was entirely destroyed. They were also seriously injuring potatoes and in some cases where potatoes followed a wheat crop of the previous year.

I reared *P. fusciceps* from maggots found in the "bulbs" of young wheat plants in Kansas in 1909, and can add this host plant to the list presented by Mr. Schoene. It is doubtful if wheat constitutes a favorable host plant for this insect, although in Idaho I have noticed serious infestation to potatoes where this crop followed wheat.

MR. N. F. HOWARD: This species formed a considerable per cent of 10,000 adults of the three species (*brassicæ, fusciceps, cepetorum*) caught at Greenbay, Wis., last summer. It was also found hibernating in the pupal stage in onions, and was bred from both cabbage and onion.

MR. GEORGE A. DEAN: In Kansas, I found in two or three cases that corn was badly infested where it followed wheat. I do not know whether the maggots infested the wheat planted the previous year, but I did find that it was much worse in the two or three corn fields which followed wheat.

PRESIDENT GLENN W. HERRICK: We will now hear the paper by Mr. J. G. Sanders.

RECORDS OF LACHNOSTERNA IN WISCONSIN

By J. G. SANDERS, *Madison, Wis.*

(Withdrawn for publication elsewhere)

PRESIDENT GLENN W. HERRICK: I know there are many comments that could be made on this but we thought it might be best to defer discussion until we have had the paper by Mr. Davis.

A REPORT ON WHITE GRUB INVESTIGATIONS

By J. J. DAVIS, *West Lafayette, Ind.*

(Paper not received in time for publication)

PRESIDENT GLENN W. HERRICK: Now these interesting papers are open for discussion.

MR. E. P. FELT: I wish to inquire if any attempt has been made to destroy the white grub in the fall before it goes any depth into the soil? In September I found them mostly a quarter or half an inch below the surface. I wonder if there is any way of destroying them early.

MR. J. J. DAVIS: We have made no effort to destroy them except by fall plowing. It cannot be depended upon to control the grubs except in years when they are transforming to pupæ and then fall plowing, especially early plowing will destroy from 75 to 95 per cent of the prepupæ, pupæ, and recently issued beetles.

MR. G. G. AINSLIE: I should like to ask Mr. Sanders if he can tell the proportion of sexes that came to light at night?

MR. J. G. SANDERS: We have no records in Wisconsin regarding the time of appearance of sexes in evening flights. It takes a great amount of work in collecting and determining large numbers of beetles. We were assisted in this work by Mr. Neal F. Howard and Mr. Stewart C. Chandler.

MR. T. J. HEADLEE: The white-grub problem in New Jersey appears to differ from that which has been described. Most of the damage has been done to lawns, golf greens and strawberry fields. In none of these places, except in the last, can we use the means of control ordinarily recommended. Because of this fact we have made preliminary trials of soil fumigants. The tests with carbon bisulphide indicated that three quarters of an ounce to the square foot would be sufficient to destroy all the grubs infesting red-shale soil, providing the work were done when the soil was just wet enough to work well and the temperature 70° to 75° F. The experiments in the same series indicated also that one ounce of the carbon bisulphide per square foot would not seriously injure blue grass or white clover under the conditions of temperature and moisture above stated.

MR. WILLIAM MOORE: I was interested in Mr. Sanders' paper as we have been doing a little white-grub work in Minnesota. The one

point I was rather interested in—he speaks about the differences of distribution of species in small areas. In Minnesota we find a predominance of *L. fusca* in southeast Minneapolis, while in St. Anthony Park, three or four miles distant, we found *L. rugosa* most abundant. In Stillwater there is a large per cent of *fusca* and *dubia*. We found *dubia* and *grandis* were northern species. On the north border in collecting we found them very abundant on the west and again while coming in on the eastern border, while the central showed *grandis* most abundant. One collection at Stillwater, where we worked three-fourths of an hour, we found *grandis*, *dubia* and *fusca*. I was surprised at the predominance of females as you usually find a predominance of males.

MR. J. G. SANDERS: In taking records of individuals it is necessary to make note of the rate found in the early part of the flying season. After the middle of the season we find ten to one of *fusca*.

MRS. L. C. R. SMYTH: I happen to be rather familiar with the life-histories in Porto Rico and was interested in one of the discussions with regard to variation of occurrences. Porto Rico is some forty miles wide and the species that occur on the northern portion are quite distinct from those on the southern. They have not been identified but have been given locality names.

The life-history of one species covers a period of from two to five years. I happen to know that in Porto Rico the life-history of another species of white grub has been shortened to seven months, from the laying of the egg to the issuance of the adult beetle. A number of species may pass their life-history in thirteen months. The climatic conditions are such that they do not need to bore deep into the earth. The average temperature in summer is 72° and in winter 70°.

MR. J. J. DAVIS: I would add that there seem to be at least three factors limiting the distribution of different species, namely—soil, trees and elevation. Certain species are found in sandy soils which do not occur elsewhere and vice versa. The food preference of the different species of beetles varies considerably as is shown by our collection records. The effect of elevation is well shown by our collections at Lafayette where we have three elevations; one along the Wabash River which is sometimes overflowed, one a little higher up, say about 75 feet, and a third about two miles back which is probably 75 to 100 feet higher than the second elevation. In the lowest area at Lafayette and in the low ground elsewhere in the state we find *Lachnosterna vehemens* common and not occurring at the higher elevations and adversely we find species which occur only on the highest elevations.

Adjournment, 5.00 p. m.

AFTERNOON SESSION

Wednesday, December 29, 1915, 1.30 p. m.

PRESIDENT GLENN W. HERRICK: We will have the first paper this afternoon by Mr. Schoene.

NOTES ON THE BIOLOGY OF PEGOMYA BRASSICÆ BOUCHÉ[1]

By W. J. SCHOENE, *Blacksburg, Va.*

This paper deals with some conditions that affect the number of broods. The spring brood of adults or those emerging from the overwintering pupæ, are comparatively regular in their time of appearance. This fact has been vouched for by many entomologists. The time that the first flies emerge in the spring depends somewhat upon the weather. During six seasons the first individuals were taken about the time the Windsor cherries were in bloom, or between the 1st and 16th of May. By covering small areas of infested cabbage fields with cloth screens, and catching the flies as they came from the soil, it was learned that the adults emerge during a period of five weeks or longer. Our results also suggest that the time the flies first appear in spring may be influenced by such characters as type of soil, depth to which the field has been plowed, and the slope of the land.

The adults maturing in mid-summer are very irregular in their time of appearance. There are probably several factors that contribute to this irregularity, but it is primarily because the younger stages of the insect are affected by the weather, and that the pupal stage may be greatly prolonged. This irregularity in the life-history of the insect was noted by Slingerland, who states as follows: "Most of the puparia under our observation gave out the flies in about twenty days, in June; with some it lasted only fifteen days, with quite a number, nearly two months, with others three months. . . . ." Slingerland also observed that, "these are very surprising facts when one understands that all of these puparia came from the first brood of maggots. There is no hint in literature to any such retardation in development." We have noticed this delay of development as described many times. At first it was believed to be due to unnatural conditions maintained in the breeding cage. However, by placing the insects outside, and by screening portions of fields containing infested plants, we learned that the retardation behavior mentioned by Slingerland occurs regularly, each summer, in western New York.

[1] Contribution from the Department of Entomology of the New York State Experiment Station, Geneva, N. Y.

After this fact had been determined certain simple experiments were initiated, the results of which have shown that this delay or retardation is much more apparent under some conditions than others. These results are stated tersely as follows: First, when the puparia were held at a temperature in which the daily maximum readings averaged 78° F. and the minimum readings averaged 56° F., the so-called delay in development was practically absent, only a small percentage of the individuals being affected. Second, when the puparia were held at a high temperature, such as frequently occurs in western New York, a small number completed their development several days sooner than usual, while others remained quiescent and showed no visible development, while the high temperature was maintained. By holding these retarded individuals at a low temperature some were able to finish their development, though many died.

This behavior of the species has been interpreted in the same way as that outlined by Osborn[1] and Webster[2] for the Hessian fly, which is, namely, that high temperature or severe drouth causes a retardation of developing larvæ and pupæ, which lasts until low temperature returns.

The effect of this retardation behavior on the life-history of the insect in western New York is very apparent by a study of breeding records and observations made during the summer of 1909 and 1911. In 1909 there were three well-marked broods of adults. The first brood emerged during the latter part of May and the first of June; the second brood flies appeared during the latter part of June and continued to emerge through July, and the third brood emerged during the period of August 26 to September 27. These data were secured by covering large numbers of infested plants with cloth screens and capturing the adults as they issued from the soil. However, the adults were abundant everywhere about cabbage fields during the periods mentioned. In 1911 the situation was very different. The first brood of adults emerged as usual. The second brood was marked by the appearance in cages of a few individuals between June 30 and July 6. No adults emerged in the laboratory between this date and the first of September. During this period adults were very scarce in the field. A few of our first-brood pupæ gave out flies between August 31 and September 9, but adults were still very scarce in the field and continued so until the 23d of September. However, they were conspicuous in cabbage fields from the above date until October 8. The third brood appeared so late that many of the adults, eggs and larvæ were destroyed by the cold.

[1] U. S. Ent. Bul. 16:24.
[2] U. S. Ent. Cir. 70:11.

To sum up, there were three effective broods of this insect in 1909 while during the summer of 1911 there was only one brood of insects present in sufficient numbers to be of economic importance. In western New York there are two periods each year when adults can be found about cabbage plants—in the spring, and in the fall. The spring adults come largely from the autumn brood of larvæ, though some flies are from delayed pupæ of the first and second generation of the previous season. The adults found in the autumn are from both first and second brood pupæ.

PRESIDENT GLENN W. HERRICK: Is there any discussion?

MR. T. J. HEADLEE: I should like to ask to what general cause the speaker ascribes this retardation.

MR. W. J. SCHOENE: After observing this insect for eight seasons, we have decided that the insect thrives best in a cold moist climate. The normal summer weather in Western New York is unfavorable to the species and, like some other insects, it remains dormant during the summer period.

MR. T. J. HEADLEE: I would like to ask whether moisture plays a part.

MR. W. J. SCHOENE: Moisture and temperature are very closely related and it is difficult to separate the influence of these conditions. Judging from some experiments out of doors, moisture had little to do in causing this delay and certainly has no effect after the larva pupates.

MR. W. C. O'KANE: This question of delay of individuals brings to mind the life-history of the apple maggot: We found a part of the individuals of that species leaving the pupal stage the second summer instead of the first summer. These irregularities occurred with groups of individuals, all of which so far as human measurements could determine, had the same physical surroundings. This appeared to be a characteristic of the species, as much a part of its nature as any of its obvious physical characteristics. In effect it provided against the serious results to the species that would otherwise follow non-fruiting of apple trees in large areas.

MR. T. J. HEADLEE: It seems probable from the results of the work in other biological lines that activities of an organism incident to an inherited physical or chemical structure are initated by stimuli arising from its environment and that these stimuli can be found and measured.

Regarding the impracticability of separating the effects of temperature and moisture, I desire to say that my experience indicates that the operation is one which requires proper machinery.

MR. H. A. GOSSARD: In some cases I have had them carrying over until the third year where normally their development takes place in one, with the temperature and moisture conditions practically identical. Why they should carry over except for the propagation of the species is more than I can say—why a certain number carry over until a third year rather than come out the first and second year.

MR. T. J. HEADLEE: It seems to me that we are making the mistake of assuming that temperature and moisture are the only important variables in the insect environment. As a matter of fact temperature and moisture are only two of a number of factors, and the fact that insects show differences in behavior when subjected to exactly the same temperature and moisture is no reason to conclude that the stimuli which initated the activities resulting in these differences can not be found and measured. We must remember that variation in light, barometric pressure, and various chemical stimuli have not been taken into consideration.

PRESIDENT GLENN W. HERRICK: We will now listen to the next paper, by Mr. Geo. A. Dean.

THE HESSIAN FLY TRAIN

By GEO. A. DEAN, *Entomologist, Kansas State Agricultural Experiment Station*

Since its first appearance in Kansas as an important factor in wheat production, the Hessian fly has alternately disappeared and reappeared. During the forty-four years of its known presence in the state it has produced seven different outbreaks, the last and the greatest of which destroyed not less than fifteen million bushels of the wheat of the 1915 crop. Believing that not only the attention of the farmers could best be called to the seriousness of the infestation, but also that more interest could be created in the control methods and that a larger number of wheat-growers could be reached within a short time, the Kansas Agricultural College decided to request the Santa Fé Railway Company, which had a large mileage in the infested districts, to run a Hessian fly train. In previous years a number of special institute trains had been run by the Santa Fé and the other principal railway lines in the state, but to operate an exclusive insect train was a new departure. However, the Santa Fé, which has always stood ready to coöperate with the College and Experiment Station, granted the request.

A chart of the infested districts was furnished the Dean of the Extension Division who met with the officials of the Santa Fé and prepared a schedule consisting of sixty-two stops. It was left entirely with the College to decide as to the best time to run the train and it

was felt that, inasmuch as the methods of control of the fly should begin as soon as possible after harvest, the best and most opportune time for the train would be the week just before the beginning of harvest.

The train consisted of a baggage car, two modern steel day coaches, each with a seating capacity of eighty-eight persons, which were used for lecture cars, and a private car, consisting of parlor and observation, dining and sleeping compartments. It was understood at the beginning that the train was to be an exclusive Hessian fly train and thus it was advertised as the Hessian Fly Special, operated by the Kansas State Agricultural College in coöperation with the Santa Fé. The speakers consisted of three entomologists of the Agricultural College, one entomologist of the United States Department of Agriculture, the head of the Department of Agronomy, the Superintendent of Farmers' Institutes, of the College, and one county demonstration agent. In addition to the lectures, the company consisted of the agricultural agent of the Santa Fé, the publicity agent of the Santa Fé, the publicity agent of the College, and representatives of some of the principal newspapers and farm publications. The divisional superintendents and roadmasters accompanied the train over their respective divisions of the road.

Addresses were made at all of the sixty-two places scheduled. In fact, at nearly all the places the attendance was such as to require two speakers and, on several occasions, it required a third speaker to accommodate the large crowd. If the attendance did not exceed two hundred, the two speakers took care of them in the lecture cars, but where the crowd was over two hundred the overflow was taken in the waiting room of the depot, where a speaker was provided. Where there was not an opportunity for the insect train to stop, a lecturer was dropped off to hold a meeting at the depot or an up-town place. Later the man would be picked up by one of the regular trains and left at a station where the Hessian Fly Special was scheduled to stop. Or a man would be sent ahead on a regular train to hold a meeting and would later be picked up when the Special came through. In a few cases speakers were taken to neighboring towns in automobiles. During the entire trip, every speaker on the train gave practically the same Hessian Fly talk. The entomologists and the agronomist of the College prepared the speech, copies of which were furnished not only to the speakers, but also to all the railroad officials and publicity men who accompanied the train. The publicity men prepared beforehand all the articles to be used by the newspapers in the places where addresses were made. In other words, every address given and every newspaper article published had just one message and that was the

Hessian fly special; McPherson, attendance 286

Hessian fly special; Stafford, 76 autos, 17 makes

Hessian fly special; Anthony, attendance 186

seriousness of the infestation and what should be done to protect the crop of the next year. It is the opinion of the writer that much of the success of the Hessian fly train and the good accomplished were due to the fact that all departments and all persons concerned were together and that nothing was said or done but what met with the approval and recommendation of every one. The fact that the very methods advocated for the control of the fly were in keeping with the very methods recommended by the Agronomy Department and which the progressive and successful wheat-growers knew should be practiced for maximum yields, appealed to the better judgment of even the most skeptical ones. The time allowed for each stop was about forty minutes. The speakers usually arranged for a few minutes' discussion before closing the meeting. Specimen cases, charts, and illustrated material were used in nearly all lectures. As the men left the lecture cars or the waiting room they were given circulars on the Hessian fly and the preparation of the seed bed for wheat. The Hessian fly circular was printed primarily for the occasion. It was simply a timely article emphasizing the methods of control and closing with a brief life history of the fly.

In nearly all cases large crowds met the Hessian Fly Special and the total attendance for the week was appproximately seven thousand. The farmers came with a desire to learn of better methods of farming which would reduce the loss from the Hessian fly. A remarkable interest was taken in what the lecturers had to say. At Stafford, Kansas, for example, 317 farmers met the train, and after the cars were filled an overflow meeting was held in the station. Three men were giving the Hessian Fly talk at the same time. There were seventy-six motor cars, representing seventeen different companies, parked near the station.

Mr. Frank Jarrell, the publicity agent for the Santa Fé, at the close of the week, said "it is beyond doubt one of the most successful institute trains ever operated by my company. The vitally interesting thing to me was the interest in better farming, shown by the men who met the train. The very evident wish which these men have shown to learn of Hessian fly control indicates a very hopeful future for Kansas agriculture, for it shows that there is a more general belief than ever in scientific agriculture, which, after all, is nothing more nor less than business farming."

PRESIDENT GLENN W. HERRICK: It seems to me that it will be well to defer discussion until we have the paper by Mr. Gossard which follows closely the same lines.

COUNTY COÖPERATION TO REDUCE HESSIAN FLY INJURY

By H. A. Gossard, *Wooster, Ohio*

Our first effort in Ohio to completely organize the farmers, in a definite territory, to act as a unit in choosing the date for seeding wheat, was made the past fall. Since our success in inducing almost every farmer in a whole county to coöperate with us was unexpected, especially so, since our effort was concentrated on one township only, it may be worth while to describe the method followed.

The first steps toward organizing were taken by a few farmers of Elizabeth Township, Miami County, where the crop had been partially destroyed by the fly for several consecutive seasons. These requested the aid of their County Agent, M. C. Thomas, who was superintendent of the Miami County Experiment Farm, and he, in turn, requested my help in the movement. To enlist interest a meeting was arranged for at one of the villages of the township. Three or four of the most successful farmers of the township were put on the program to give fifteen-minute talks on various agricultural topics which they were specially qualified to discuss. This insured a crowd drawn from all parts of the township. I was invited to discuss the Hessian fly for a half hour, after which an organization was made, one man being appointed in each school district to induce his neighbors to sign a pledge to await the advice of the Station Entomologist and the County Agent before seeding. I think the pledging feature was not altogether successfully worked, nor do I consider it either a necessary or even a desirable part of such a campaign. Most farmers are willing to wait for any reasonable length of time for a signal to sow, but nearly all will balk at binding themselves to await the decision of a man who is personally somewhat of a stranger to them, and who might, to their minds, turn out to be an impracticable visionary. These school-district committeemen were of great use, however, in solidifying sentiment, distributing literature, etc.

My next step was to write to Professors Dean and Haseman, both of whom I knew to have had some experience with this coöperative plan of seeding, and obtain from them a statement of results. I also requested the names of county agents who had had experience with the work, and of farmers who had grown wheat under the plan. Three of the Kansas county agents wrote me, at Professor Dean's request, giving me their working plans and results. Eight or ten Kansas farmers also responded to my appeal for a statement of their experience. These letters from the farmers proved very useful, since a farmer will

sometimes accept the testimony of a fellow farmer more quickly than he will that of a professional entomologist or of a county agent. Multiple copies of all these letters were made and put in the hands of the county agent, and were given to some of the committeemen. Part of these were published in the local newspapers and the county agent published reports in the county papers of all public meetings.

However, the clinching factor, which rendered all this publicity work effective and influenced all the farmers of the county to fall into line without any organized solicitation, outside of Elizabeth township, was the installation of a breeding cage and the keeping of an egg-laying record at the County Experiment Farm. Had the farmers thought we were merely guessing at the date when the flies had gone, some of them would doubtless have concluded that they could do just as good a job at that, as an entomologist one hundred miles or more away; but when they realized that we had a definite method for determining when the brood was past *in their own county, under the conditions of 1915*, all were willing to wait for any reasonable length of time to learn our results; in fact, they were afraid to disregard them.

The breeding cage was simply a wooden box two or three feet long, about two feet wide and perhaps sixteen or eighteen inches high, without any bottom and a small hole in the middle of the top, over which a lantern globe was placed and covered with cheesecloth. Stubble and top soil, containing puparia in abundance, was collected from a plot badly infested the preceding season, dampened, and put into the cage September 14. This, I attended to personally, and the next morning gave to the county agent, Mr. Eastwood, who had succeeded Mr. Thomas, instructions for making the count and differentiating the fly with a magnifying glass from the other flies appearing in the cage. A daily record of the hatch was thenceforward kept. He was also taught to recognize the eggs on the wheat blades, and a few days later he marked 100 wheat plants, located at intervals down a suitable drill row, by putting hog-nose rings about them. All eggs were removed from the blades of these plants by rubbing them off with the finger, and the next day and each succeeding day, thereafter, the eggs were counted and then removed. The egg-laying record will show a maximum rate of egg-laying in the field a few days after the maximum emergence of flies in the cage. When both records show that the crest of the brood is well passed, and weather conditions for the season have been normal, or without a marked deficiency of moisture, it is usually best to recommend seeding, since the wheat will not be up and inviting to the flies for ten days or two weeks after it is sown, and by that time practically all of the flies will have disappeared.

We planned at first to publish daily, in the county papers, the record of the hatch and of egg-laying, to insure control of the more hasty farmers, but Mr. Eastwood judged this to be unnecessary, and so the record was not published until September 27, when I advised that the signal be given to seed. Mr. Eastwood was able to learn of only a few fields in the county that had been sown at that time. Nearly all of the seeding was done between October 1 and October 20 and during the fall developed no fly. The prospects for a good crop, wholly free from the fly over the whole county, would be perfect were it not for the numerous puparia which have developed in volunteer wheat, scattered through the clover fields, many of which have not even been pastured. Puparia can be found quite plentifully even in rather closely grazed clover fields.

A similar plan was followed in Clermont County, but, owing to a later beginning, was not so generally successful. However, County Agent Herron expressed the belief that a great majority of his farmers had awaited his advice, and that in another year the coöperation could be made practically unanimous. Very similar results were reached in one of the townships of Greene County, adjoining Miami, the unofficial management there awaiting the advice of Mr. Eastwood, because they had no county agent, nor any county farm of their own, on which to conduct the breeding tests.

Coöperative sowing in Ohio is bound to be only partially successful during droughty years, because of the flies issuing so tardily and irregularly from the stubble fields, seeded to clover, which cannot be plowed under; and where the seeding has been timed to give perfect success, the final harvest will be somewhat doubtful in all years, unless we can separate the production of wheat and clover.

PRESIDENT GLENN W. HERRICK: Is there any discussion of these two papers?

SECRETARY A. F. BURGESS: One point in Mr. Dean's paper which struck me very forcibly was that all these entomologists, agriculturists and newspaper men told the same story. That is one of the places where our entomological work and extension work frequently falls down—too many cooks. The arrangement of having all the lecturers tell the same story and the newspapers give the same report is a wonderful thing. It is something that should be copied in other endeavors of the same kind. A train that goes out for the purpose of distributing information should distribute information that does not contradict.

PRESIDENT GLENN W. HERRICK: I have been impressed with the value of these two papers as illustrative of effective and successful

methods of putting entomological information before the farmer. This is a point where many of us fail. We get lots of information on a certain problem, publish it and then often send it to the wrong men who throw it into the waste basket or allow it to lie on dusty shelves unread and unused.

MR. F. M. WEBSTER: In 1891 Dr. C. V. Riley attempted to introduce a European parasite of the Hessian fly. It was placed in the field but little has been heard concerning it up to the present time. The facts concerning its introduction and recovery are given in the following paper by Mr. W. R. McConnell.

SUMMARY OF FACTS ABOUT THE INTRODUCTION OF PLEUROTROPIS EPIGONUS WALK

By W. R. MCCONNELL

The species was originally described under the name *Entedon epigonus* Walker, and apparently is the same as *Semiotellus nigripes* Lindeman, as Dr. Riley compared specimens with Walker's types. (Forbes, *Insect Life*, 1892, 73.) The species is now placed in the genus *Pleurotropis*.

INTRODUCTION INTO AMERICA

1891—Riley received infested puparia from Mr. Fred Enock, of London, England, during the spring of that year.

This infested material was distributed to Forbes in Illinois, Cook in Michigan (Agricultural College), and Fletcher in Canada (Ottawa). (Forbes, *Insect Life*, V, 1892, 73; Riley, *Insect Life*, 1893, 133–4.)

No report from Cook and Fletcher, as far as I can find.

Forbes (*Insect Life*, V, 1892, 73) reported rearing adults from the original material in a small enclosed plat experiment, but up to August 15, 1892, had recovered no specimens from fields in which material was distributed. No further statement regarding the success of Forbes' experiments has been found.

1894—Material from Enock placed in field at Fredericktown, Md., and on farm of C. Morgan Eldridge at Cecilton, Md. (Howard, *Insect Life*, VI, 1894, p. 375.) (Fredericktown must be the Frederick of today.)

No further report from the Fredericktown introduction.

At Cecilton, Md., Ashmead succeeded in sweeping up one ♂ during May of the next year. (Howard, *Insect Life*, VII, 1895, 414–5.)

There seems to be no further records until our rearings at Hagerstown began in 1915.

In the following table is given the record of our rearings at the Hagerstown Laboratory:

Locality	No. of Specimens Reared	Collector
Hagerstown, Md.	14	McConnell and Myers
Andersonburg, Pa.	1	Myers
Warfordsburg, Pa.	1	Myers
Montoursville, Pa.	1	Myers
Ford City, Pa.	1	McConnell
Greenville, Pa.	1	McConnell
Total	19 specimens	

All of the localities except the last two are east of the Allegheny Mountains. Ford City, Pa., is on the Allegheny River, and Greenville is on the western edge of Pennsylvania.

We know practically nothing of its life-history, as I have never succeeded in inducing it to oviposit. Adults have emerged in cages from April to June inclusive and from September to December inclusive. Most of the specimens reared were males.

Importance

Riley stated that it was introduced because it was more abundant in England and far more beneficial than any of our native species. Enock was probably his authority for conditions in England. His statement for this country seems very doubtful, in view of the scarcity of the species. It may not be adapted to the climate, and again it may become very abundant during a widespread outbreak of the Hessian fly. The latter point of view is probably more nearly correct, since it seems to be able to maintain itself over periods when the host is scarce, in spite of the predominance of males.

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Hagerstown, Md., December 22, 1915.

PRESIDENT GLENN W. HERRICK: The next paper on the program is by R. R. Parker of Montana. As the author is not present the paper will be read by J. R. Parker.

DISPERSAL OF MUSCA DOMESTICA LINNÆUS UNDER CITY CONDITIONS

By RALPH R. PARKER, *Bozeman, Mont.*

(Not received in time for publication in this issue)

PRESIDENT GLENN W. HERRICK: Is there any remark or discussion?

MR. MAX KISLINK, JR.: I have been working on dispersion of the house-fly for the Bureau of Entomology. At the Animal Industry Farm at Bethesda, Md., we liberated from the 30th of June to September 10, 200 colored flies. All were liberated from about the same point on this farm. We bred these in cages from a lot of maggots taken from pig manure.

The method of coloring was with colored chalk and marking freshly emerged flies, not more than a day old. First we put traps within 500 yards from the point we liberated the flies and caught a good many in that way. Then we increased the distance. We also made rounds among the residents and whenever they saw a colored fly they would swat it. Some people who were not notified of it thought the flies were carriers of a certain kind of spotted fever. The results of the summer showed that the flight spread out over an area of one and a quarter miles. In the experiment I noted that the flies did not go in any particular direction with the wind. In fact I have often noticed the flies going against the wind.

PRESIDENT GLENN W. HERRICK: Did you put the chalk on their wings or on their bodies?

MR. MAX KISLINK, JR.: As soon as the flies emerged we let them out of the breeding cages into a trap. Then we put the flies into paper bags heavily chalked, shook them up and when they were let loose there was quite a cloud of color.

PRESIDENT GLENN W. HERRICK: For the past three years I have been spending a part of the summer on Cranberry Lake in the Adirondacks, one and one-eighth miles from the village of Cranberry Lake. There are no animals on that side of the lake but toward the latter part of the summer we are troubled with house-flies. There are no breeding places for them and they must come from the village one and one-eighth miles across the lake in a diagonal direction. I see no

other place where they can breed. They would in this case have to fly continuously across the lake.

MR. T. J. HEADLEE: It was noted in England where flies had come from five miles away.

PRESIDENT GLENN W. HERRICK: The next paper will be by Mr. Joseph H. Merrill.

LIFE-HISTORY AND HABITS OF TWO NEW NEMATODES PARASITIC ON INSECTS

By JOSEPH H. MERRILL, *Manhattan, Kans.*

(Withdrawn for publication elsewhere)

PRESIDENT GLENN W. HERRICK: It is interesting to find that there are some nematode forms that seem to be of some use in life.

I did not understand Mr. Merrill to say whether they actually killed the insects.

MR. J. H. MERRILL: A tent was placed around the trunk of an elm tree so that all emerging insects might be secured for breeding purposes. There were 121 *Saperda tridentata* which emerged from this tree and were placed in breeding cages, but in no instance did any of these insects deposit eggs. Not only was the vitality of the insects lowered but their natural functions were so interfered with that eggs did not even start to develop within their bodies. The death rate, due to nematode parasitism, was 100 per cent. Several experiments were carried on by placing termites in soil known to contain nematodes. In twelve days all of the termites had died, due to this nematode parasitism.

MR. DON C. MOTE: I would like to inquire whether these nematodes are truly parasitic. I take it from the paper that Mr. Merrill was able to rear them from the egg to the adult stage in cultures. This fact would seem to indicate that they are not necessarily dependent upon taking up their abode in the insects' intestines for their development. Generally nematode parasites attain a certain point in this development outside the host beyond which they cannot go unless they reach their normal habitat within their host.

MR. J. H. MERRILL: These nematodes were found to be parasitic on *Saperda tridentata* and *Leucotermes lucifugus*. The nematodes found in *S. tridentata* were fed in cultures on the macerated bodies of insects, while those found in the termites were fed exclusively on termites as we could easily secure a plentiful supply of these insects.

MR. DON C. MOTE: At what time during the developmental stage did infestation occur?

MR. J. H. MERRILL: How and when the nematodes gain entrance into the insects are two questions that are yet to be solved. As the nematodes were found in the intestines of *S. tridentata* it is possible that the nematode eggs may have been taken in with the food. As the nematode in the termites were found in the head and mouth cavity, these may have entered while the worms were still young. Although they could enter when quite small, they could not complete their development within the termite.

PRESIDENT GLENN W. HERRICK: Any more questions concerning this paper? If not we will pass to the next paper by Mr. J. W. Chapman and R. W. Glaser.

FURTHER STUDIES ON WILT OF GIPSY MOTH CATERPILLARS[1]

By J. W. CHAPMAN and R. W. GLASER

INTRODUCTION

During the past two summers (1914–1915) certain questions in connection with wilt of gipsy moth caterpillars have begun to clarify. The published experimental results obtained during the summer of 1913, while helpful in interpreting many of the phenomena encountered in this interesting problem, nevertheless left much in doubt. Our efforts were renewed during the summer of 1914 with the hope of verifying all of our previous experiments (1913) and of solving some of the questions towards which we had begun to assume a sceptical attitude. Many interesting matters were forcibly impressed upon us during the course of this study which extended over two seasons. The results obtained in 1914 were discouraging although instructive. In 1915, however, we not only obtained data harmonizing with those of 1913, but surpassing our expectations by yielding new and interesting results. This work also clearly revealed the inadequacy of some of our methods.

In order that other investigators interested in the polyhedral diseases of insects may be spared many of the tedious difficulties which we encountered we present our work historically, and will attempt to give an account of the methods which must be pursued in order to ensure dependable results. This method of procedure will also have the advantage of placing our new results in a proper light.

[1] Contribution from the U. S. Bureau of Entomology in coöperation with the Bussey Institution of Harvard University. (Bussey Institution No. 110.)

Summary of Our Previous Work

The results obtained by our previous studies may be summarized as follows:

1. The wilt of gipsy moth caterpillers is a true infectious disease distributed over the entire territory infested by the gipsy moth.
2. Epidemics of the disease occur only in localities heavily infested by the gipsy moth.
3. Climatic conditions appear to bear an important relation to wilt in the field.
4. The disease is more prevalent among older than among younger caterpillars, but the latter also die of wilt in the field.
5. No diagnosis of wilt is valid unless polyhedra are demonstrated microscopically.
6. There is no record of the occurrence of wilt in the gipsy moth in America prior to 1900.
7. Minute dancing granules may be observed in wet smears.
8. Polyhedra are probably reaction bodies belonging to the highly differentiated albumins, the nucleoproteids.
9. The pathology of wilt does not vary with the age of the caterpillars.
10. The polyhedra originate in the nuclei of the tracheal matrix, hypodermal, fat, and blood cells.
11. The nuclei of the tracheal matrix and blood cells seem to be the first tissue nuclei affected.
12. Many minute violently dancing granules are found in the pathological nuclei of fresh tissue.
13. Giemsa's stain demonstrates many little granules in the nuclei of diseased tissue sections.
14. The alimentary canal seems to be the last organ in the body to disintegrate.
15. Two types of blood corpuscles exist in normal hæmolymph.
16. Two types of pathological blood corpuscles exist in diseased caterpillars.
17. The blood is a fairly reliable index of a caterpillar's condition.
18. The blood test is impracticable for large experimental series.
19. Bacteria are not etiologically related to wilt.
20. The virus of wilt is filterable with difficulty.
21. Such a filtrate is free from bacteria and polyhedral bodies.
22. Caterpillars that have died from infection with filtered virus are flaccid, completely disintegrated, and full of polyhedra.
23. Minute dancing granules were observed in the Berkefeld filtrates. These may be identical with certain granules observed in smears and tissue nuclei (sub. 7, 12, and 13) and may be etiologically significant.

24. The incubation period of wilt varies, and temperature at times seems to bear an important relation to this variation.

25. A large number of caterpillars used in the experiments died of disturbances in their normal physiological activities.

26. The success of wilt infection experiments is absolutely dependent upon attention to seemingly insignificant details.

27. Genetic immunity of certain individuals is probable.

28. Active immunization with sublethal doses is possible.

29. The polyhedral bodies may be stages of the filterable virus, but as yet no evidence to substantiate this view has been produced.

30. Infection naturally takes place through the mouth by means of the food.

31. There is no evidence that the wind is an important factor in distributing the disease.

32. Some of the imported parasites may be important factors in aiding the dispersion of wilt.

33. Although probable, there is no definite evidence as yet that wilt is transmitted from one generation to another.

Problems Requiring Further Investigation

From a review of our work during 1913 it seemed apparent that many wilt problems needed further investigation and verification. For this reason we concentrated our work upon the following questions:

(a) Can we obtain further evidence in order to substantiate our view that wilt is a true infectious disease?

(b) Can we produce further evidence that wilt is caused by a minute filterable organism?

(c) If wilt is caused by a filterable virus can we obtain some idea of its size?

(d) Has wilt a definite period elapsing between inoculation and death?

(e) What influence do climatic conditions (temperature and humidity) have on the length of this period?

(f) Does immunity towards wilt exist in certain members of the gipsy moth race?

(g) Is wilt transmitted from one generation to the next through the egg?

Difficulties Encountered in 1914

In order more lucidly to illustrate the satisfactory methods devised during the summer of 1915 we would like to present five out of fifteen experiments performed during the summer of 1914. The gipsy moth caterpillars used for these experiments were collected in the field while in the third and fourth instars from localities where no wilt had been noticed up to the time of the collection. The animals were

taken to the laboratory, and isolated from one another in autoclaved pasteboard or sterile tin boxes. Thus by isolation, all animals that harbored the disease and died before being used for experimental purposes were prevented from infecting others. This precaution was found necessary for the reason that it is impossible to determine during the early stages of the disease, whether or not a caterpillar is free from wilt infection. Of course Escherich's blood test method for eliminating chronic cases might have been used, but Glaser and Chapman (1913) and Glaser (1915) have shown that the blood test is impracticable for large experimental series.

Caterpillars dead from wilt were emulsified with sterile water. This material (amounting to about 100 c.c.) was filtered through cotton and later through paper. The filtrate thus obtained was passed through a Berkefeld Grade "N" filter by the use of a vacuum of approximately 28 inches. This Berkefeld filtrate was used for the infection experiments. Of course, the filtrate was tested for its bacterial sterility by plating on ordinary nutrient media. If the proper technical precautions are taken the filtrate obtained will be free from bacteria and polyhedral bodies.

The caterpillars were infected by holding the animals with their ventral side up. By means of a sterile eye dropper a drop of the filtrate was then placed directly over the mandibles. By exercising sufficient patience the animals can be made to drink the drop or even two or three large drops. It must be borne in mind that caterpillars will not drink prior to moulting, so it is important to obtain them after moulting or two or three days previous to this act. Moreover, caterpillars which have recently fed are unwilling to drink and therefore it is best to starve them for 24 hours before attempting an infection.

Every caterpillar in our experiments was infected with the same amount of the virus. Suffice it to say, that we prepared the virus in the same way for each experiment, and further attempted to have conditions as constant as possible.

Table I gives the results obtained in the first experiment. Twenty-five caterpillars were infected with the Berkefeld "N" filtrate and 25 controls were infected with the same filtrate sterilized by autoclaving for 20 minutes. Eighteen caterpillars died of wilt in the experiment and 19 in the controls. One individual escaped; one died of another cause (possibly bacterial infection), and 11 moths were obtained. Table II is self-explanatory. Tables III and IV represent similar experiments with the exception that the material was passed through the finer Grade "W" Berkefeld filter. By an examination of Tables I and II it will be seen that the deaths due to wilt in the controls exceed those in the experiments. In Table III the deaths in the experi-

ments exceed those in the controls by two. In Table IV the deaths in the experiments exceed those in the controls by 15. It was absolutely impossible to come to any conclusions on the results based on the above experiments. Table V represents an experiment in which 25 animals were infected with fresh, undiluted and unfiltered gipsy moth wilt virus. Twenty-five controls accompanied this experiment. As can be seen the deaths in the controls exceeded those in the experiments by six. Altogether fifteen experiments were performed and the results were all very similar to those outlined above. Can such discouraging results find an explanation, and how can they be made to harmonize with those obtained in 1913? The only feasible explanation which occurred to us was that many of the caterpillars used in our experiments in 1914 were chronically infected with wilt before being collected and that this accounted for the high mortality in the controls. Why some of the animals infected with the unsterilized virus survived and produced moths can possibly be explained by the suggestions offered by Glaser and Chapman (1913) and Glaser (1915). In short it seems very likely that many individuals are naturally immune towards wilt. In the discussion of the Berkefeld filtration experiments of 1913 it was further pointed out, that the wilt virus is difficult to filter on account of the abundance of cellular débris, pigment granules, hairs and polyhedral bodies. A film very soon becomes deposited on the outside of the Berkefeld candle and of course this retards filtration. In order partially to overcome this retardation, the virus was diluted to about 100 c.c. of sterile water and filtered through a fine grade of paper prior to filtration through the candle. As is well known, however, the albuminous material, polyhedral bodies, etc., easily pass through filter paper so that it is practically impossible to obtain material for the Berkefeld filter which will not deposit a film on the candle. Absorption of material into the interior of the candle necessarily also must retard the filtration. Naturally, the old candles must be frequently replaced by sterile new ones even during the course of one filtration.

As stated previously, the results obtained in 1914 were gravely at variance with those of 1913. Evidently we were fortunate in collecting healthy material in 1913, but our 1914 results clearly demonstrated that our chance method of obtaining healthy material ended disasterously. Another method had to be devised.

Origin of Material for the 1915 Experiments

If further experimental progress was to be made, it was thought absolutely necessary to raise a stock of caterpillars free from wilt infection or at least a stock in which the wilt mortality was reduced to a

minimum. After producing such a wilt-free stock, we could then rely upon individuals from such a stock for experimental purposes and the results would be significant. During the season of 1915 we raised several sets of caterpillars from eggs. In some sets or cultures no wilt mortality occurred throughout the entire season; in most of the other cultures wilt appeared, but the mortality was low. How certain individuals in these latter cultures became infected is open to several explanations, the most probable of which would seem to be that wilt is transmitted from one generation to another through the egg. Chronic carriers of the previous generation may resist death, pupate, transform and transmit the disease, as is the case with pébrine, to certain individuals of the next generation. Some members of this second generation become susceptible and die. That carelessness was responsible for the deaths in those cultures where wilt appeared spontaneously seems highly improbable for the reason that every conceivable bacteriological precaution was taken. We even went so far as to import daily the food for the animals from a territory which had never harbored gipsy moth caterpillars. The foliage before being picked was further examined for the presence of other lepidopterous larvæ. This precaution was thought to be necessary for the reason that Chapman and Glaser (1915) found wilt prevalent amongst ten of our native species of lepidoptera and the possibility of food contamination is very great.

In 1915 two sets of eggs were hatched. One set had its origin from moths that emerged from the control experiments the previous year (1914). The other set was kindly given us by Professor Richard Goldschmidt, who for several years has been investigating certain genetical questions in connection with the gipsy moth. Some of these eggs were derived from a pure Japanese race procured by Professor Goldschmidt from Ogi, Japan; others were derived from crosses between Japanese races with a race from Germany and one from Fiume, Hungary. The caterpillars from this second set of eggs were very easily distinguished from our introduced American race, by their peculiar coloring and pattern. Professor Goldschmidt informed us that he had had very little disease in his cultures the previous year, so we thought his material ought to prove very instructive.

Altogether a great many cultures were cared for, both American and foreign. These cultures represented our stock from which we took animals whenever they were needed for experimental purposes. Some of the animals were immediately removed from the stock on hatching and isolated, others were treated in bulk. At the beginning of the season, while the caterpillars were still in the second stage, many individuals died of wilt in three American cultures. These cultures

were quickly discarded for fear that the infection might spread to the remaining individuals.

Animals needed for an experiment were taken from a particular stock culture. The remaining individuals comprising this stock were kept under close observation throughout the season *i. e.*, the number of deaths and the number of moths which emerged were recorded. Thus in most cases, we were able to determine the health of a particular culture. Needless to say, no deaths in stock or experiment were attributed to wilt unless all the gross and microscopic symptoms were typical. (See Glaser, *Journal of Agricultural Research*, Vol. IV, No. 2, p. 104.)

Simple and Passage Infections

The following experiments were performed in order to prove whether or not wilt is a true infectious disease. All caterpillars used for an experiment were taken from a particular stock and isolated in separate, small, round tin boxes measuring three-fourths inches in depth and two and one-half inches in diameter. Such tin boxes were found far superior to the pasteboard boxes used during previous seasons. By keeping the lid closed the proper humidity conditions are obtained and the food remains fresh for two or three days if not eaten. The caterpillars also moult regularly in these tin boxes and they seem not to suffer in the least from their confinement. Lastly, the tin boxes can be easily sterilized by boiling water and can be used over again repeatedly.

The stock animals were nearly all raised in glass fruit jars measuring about three and one-half inches in height and in diameter. By screwing on the tin tops, the proper humidity conditions could likewise be obtained. If the humidity increased sufficiently so that drops of water formed on the glass, a little dry sand put into the bottom of each jar soon absorbed the excess moisture.

Table VI gives the results of the first experiment. Twenty fifth stage foreign *dispar* caterpillars were isolated, ten for the experiment and ten for the controls. Caterpillars which died of wilt were ground up in a motar with sufficient sterile water to facilitate the process. This liquid was strained through cheesecloth and then diluted to 40 c.c. with sterile water. The solution was next filtered through paper in a Buchner filter by using a slight suction. Ten caterpillars were fed from an eye dropper (method of feeding described on page 152) with the Buchner filtrate and ten controls, fed with the same filtrate sterilized by autoclaving, accompanied the series. Eight caterpillars died of typical wilt in the experiment and no controls succumbed. Two controls died of an "other cause." Two moths in the experiments and eight moths in the checks emerged. In the stock culture of 240

from which the animals were derived, 1¼ per cent died spontaneously of wilt and 78 per cent of "other causes."

Tables VII and VIII represent experiments similar to the one presented on Table VI with the exceptions that fourth stage American caterpillars were used in experiment VII and Japanese third stage animals in experiment VIII.

Table IX represents an experiment performed with American fourth stage caterpillars. Five animals were used in the experiments and five in the controls. Not a single animal died from wilt.

Tables X and XI represent passage infections. A caterpillar which died in one of the previous infection experiments was ground up and diluted to 10 c.c. with sterile water. This material was strained through cotton, filtered through paper in a Buchner filter, and fed to foreign fifth stage individuals represented on Table X. Twelve individuals were fed with the Buchner filtrate; 12 were fed with this filtrate autoclaved and 33 untreated caterpillars accompanied the series. The results can be gathered by consulting the Table.

Table XI represents the next passage. A caterpillar that died in the previous experiment was used. The material was treated in the same way, *i. e.*, ground up, diluted to 10 c.c. and filtered. Fifth stage foreign caterpillars were used.

Discussion of the Infection Experiments

The following data derived from a comparative study of the mortality tables are worthy of discussion: The number of caterpillars which died of wilt in the experiments and checks; the relation between the percentage of wilt mortality in the stock cultures and the percentage of wilt in the checks; the number of caterpillars which died of "other causes" in the experiments and checks; the relation between the percentage of "other cause" mortality in the stock cultures and the percentage of deaths due to that cause in the experiments and checks; the number of moths obtained in the experiments.

In the tables the wilt mortality of the experiments equals 68 per cent; in the checks 4 per cent. How can we explain the 4 per cent wilt in the checks? By comparing the wilt mortality in the checks with the wilt mortality in the stock culture in each table, we find that the condition of the stock usually explains the wilt mortality in the checks. Thus in Table VI none of the checks died of wilt and the wilt mortality in the stock was very low (1¼ per cent). In Table VII we have two cases of wilt in the checks and the mortality in the stock is rather high (9 per cent). In Table VIII one check died of wilt and the mortality in the stock is high (11 per cent). In Table IX no wilt is recorded and none in the stock. In Table X none is recorded in the

checks and none in the stock. In Table XI one case of wilt is recorded in the checks and none in the stock. The explanation offered to account for the 4 per cent check mortality is based on the above data, namely, when the stock wilt mortality is low or zero, the checks which are derived from such stock are likely to be healthy; when the stock wilt mortality is high, some of the checks which are derived from such stock are likely to be diseased. Table XI seems to be a slight exception to this rule. In this experiment no wilt is recorded in the stock, but one in the checks. It must be borne in mind, however, that the number of this stock culture was rather small and it is really unfair to base a health estimate on it. Of course, this one check may not have been chronically infected before being used. It may have contracted the disease subsequently by accidental infection, but this seems unlikely.

Under the heading died of "other causes" are grouped all of those animals that showed none of the gross and microscopic symptoms of wilt. Caterpillars which succumbed to this "other cause" death were usually in the fourth or fifth stage. They frequently hung by their prolegs in the typical wilt fashion, but their skin was tough and did not rupture easily as is the case with typical wilted individuals. On dissection such individuals proved to be practically free from body fluids, in contradistinction to the deliquescent state of wilted animals. In many cases the organs and tissues were almost shrunken beyond recognition due to the loss of blood and body fluids. No polyhedra were ever found in such animals, but smears from the intestine revealed countless Saccromycetes and Micrococci. Sections through these caterpillars failed to reveal the above mentioned microörganisms in any organ excepting the intestine. The Saccromycete and a Micrococcus were isolated from animals which died of this disease and other healthy ones were infected with these pure cultures. We failed to reproduce the disease with either microörganism. It might be well to mention that the Saccromycete grows very readily on bean and potato agar, and the Micrococcus flourishes on beef infusion and on beef extract agar.

A very interesting fact was noticed in all of the stock cultures and experimental animals. Nearly all of the individuals which died of the "other cause" death and which revealed the Saccromycete and Micrococci microscopically and culturally, were derived from the foreign eggs given us by Professor Goldschmidt. Very few American caterpillars could be found which yielded the above named microörganisms. The few found probably became infected from the foreign stock. By comparing the tables representing American with those representing foreign animals, and further by comparing the percentage of "other

cause" deaths in the stock cultures with the same deaths in the experimental animals, actual experiments, checks and untreated individuals, the facts to which we have here called attention stand out very vividly. (Compare Tables VI, VIII, X and XI with Tables VII and IX.)

Professor Goldschmidt experienced a high mortality in some of his Japanese gipsy moth cultures. We had the opportunity to examine many of his dead animals and found that the percentage of deaths due to the "other cause" was very much greater than the percentage of wilt mortality.

So far as the "other cause" mortality is concerned, the following facts are clear:

(1) The "other cause" mortality discussed in this article is not at all comparable to the mortality similarly designated by Glaser and Chapman in 1913. In 1913 it was due to low humidity; in this case probably due to one or more microörganisms.

(2) We believe that this "other cause" mortality is a specific disease which has no direct relation to wilt.

(3) This "other cause" mortality was never found during previous seasons in our American laboratory or field animals.

(4) It appeared for the first time this year (1915) in our foreign cultures and later spread to two or three American cultures.

(5) This new disease appears only during the later stages of the caterpillars (fourth and fifth stages).

By comparing Tables VI, VII, IX and X it will be seen that from one to five moths were obtained in nearly all of the actual infection experiments. There can be no doubt that the caterpillars partook of the virus for we were very persistent in seeing that they actually drank. Therefore, we offer two explanations: first, that certain individuals among gipsy moth caterpillars are immune to wilt. We have obtained eggs from such individuals and it will be interesting to note during the next season whether this immunity is transmitted to any of the next generation. Second, that certain individuals after inoculation become chronically diseased, but are nevertheless capable of undergoing metamorphosis. If this is the case wilt might be transmitted from one generation to another through the egg. The rearing of individuals from such eggs ought to throw much light on the subject.

Berkefeld Filtrate Experiments

Glaser and Chapman (1913) showed that bacteria in the ordinary sense of the word are not etiologically related to wilt, but that the evidence is very great in favor of the view that wilt is caused by a filterable virus.

The following experiments are offered as further proof for our view. Tables XII and XIII represent two experiments which duplicate one another in every detail.

Wilted material was ground up with sterile water and strained through cheesecloth. The liquid was then filtered through paper and equalled 70 c.c. This was next filtered through a Berkefeld "N" candle by gravity. Platings were made of the filtrate and since no bacteria grew it was considered sterile for ordinary forms. A portion of this same filtrate was centrifuged electrically and the bottom sediment examined microscopically. No bacteria or polyhedral bodies could be detected in fresh and stained smears. The animals used for these two experiments were all in the fourth stage and came from an American stock. They were, furthermore, all derived from the same egg cluster. Thirty-two animals were fed, by means of an eye dropper, with the Berkefeld "N" filtrate; 28 with the filtrate sterilized by autoclaving and 20 untreated individuals accompanied this series. In one experiment, Table XII, nine out of 32 animals infected with the unsterilized virus died of wilt. Moths were obtained from all the rest. In the other experiment, Table XIII, four out of 32 animals infected with the unsterilized virus died of wilt. The remaining individuals all transformed. Table XIV represents another similar experiment with slight variations. Fifth stage American caterpillars were used. The wilted material after preparation equalled 25 c.c. This was diluted to 100 c.c. and filtered through a Berkefeld "N" candle by means of a vacuum of about 27 inches. Ten animals were fed with the filtrate and ten with the filtrate sterilized by autoclaving. Four out of the 10 animals infected with the unsterilized virus died of wilt; three in the experiment and two in the checks died of "another cause" and moths were obtained from the remainder. Of course, no death was diagnosed as wilt unless all the gross and microscopic symptoms were typical.

By comparing the Berkefeld experiments with the simple infection experiments, one is at once impressed with the small number of deaths among the infected animals (23 per cent) in the former against 68 per cent in the latter. Of course, immunity may account for a number of the moths, but the difference between the two sets of experiments is too great for the immunity theory to account for all. This difference between Berkefeld and simple infection experiments was also noticed in 1913, and in 1914, and we offer the explanation presented on page 153 (absorption by candle and film deposition). Significant in these Berkefeld experiments is the fact that none of the checks died of wilt. As can be seen from the tables (XII, XIII and XIV), the condition of the stock was responsible for these gratifying results.

Pasteur-Chamberland Filtrate Experiments

Since our experiments seem to demonstrate that the wilt virus is capable of passage through Berkefeld candles it was thought imperative to ascertain whether or not the virus could be passed through something finer, namely, through Pasteur-Chamberland filters. For this reason the two following experiments (Tables XV and XVI) were performed. The virus was prepared in the usual way and equalled 60 c.c. This was passed through a Berkefeld "N" filter (vacuum of 27 inches) after which the resulting filtrate was passed through a Pasteur-Chamberland "F" filter (vacuum of 27 inches). Fifth stage foreign caterpillars were used in both experiments and the animals were infected by the pipette method. Tables XV and XVI are self-explanatory. Suffice it to say, that not a single animal died of wilt in either the experiments or checks. These two experiments seem to demonstrate that none of the virus is capable of passage through the Pasteur-Chamberland "F" filter. In other words, the size of the organism concerned in wilt lies somewhere between the size of the Berkefeld and Pasteur-Chamberland filter pores. Of course, some of the virus may have passed through, but was not sufficient to gain a foothold on account of a natural immunity of the animals. This, however, is pure speculation at present.

Is There any Relation between Sacbrood and Wilt?

In 1913 White discovered a disease in bees caused by a filterable virus, which he named Sacbrood for the reason that the dead larvæ when removed from their cells have the appearance of a small closed sac. The main difference between Sacbrood and wilt, however, seems to consist in the fact that polyhedral bodies have never been found by White in cases of Sacbrood. Of course, this fact need not exclude the possibility of the identity of the two diseases, for the bee larval tissue reaction towards the disease may be entirely different from the caterpillar tissue reaction. Polyhedral bodies may not be formed when the virus invades bee larvæ although formed when the same virus gains entrance to the caterpillar body.

Through the kindness of Dr. G. F. White, we obtained some Sacbrood material. At the same time we sent Dr. White some wilt material so that he could perform the reciprocal infection, *i. e.*, infect bee larvæ with the wilt virus. None of Dr. White's experimental bee larvæ developed Sacbrood or wilt as it is known in caterpillars. Tables XVII and XVIII represent two experiments accompanied by controls, in which gipsy moth caterpillars were infected with Sacbrood. As can be seen none of the animals so treated succumbed to wilt. From these experiments performed by us in coöperation with Dr. White, we conclude that wilt and Sacbrood are two distinct diseases.

Period from Infection to Death

In wilt a definite period elapses between the time of inoculation by feeding and death. This period varies slightly depending on the dosage, but is fairly constant in a certain class of experiments in which the dosages are constant. Tables XIX and XX graphically illustrate what happened in our simple and Berkefeld infection experiments. Table XIX represents the simple infections. Each square along the ordinate represents the greatest number of caterpillars that died on a particular day; the abscissa represents the number of days covered by the experiments. The first deaths occurred 13 days and the last deaths 27 days after inoculation. The highest point in the mortality is reached 18 days after inoculation. The mean for the entire simple infection experiments is 20 days. Table XX represents the Berkefeld infections. In this series the first death occurred 15 days and the last 29 days after inoculation. The highest point in the mortality is reached 23 days after inoculation. The mean for the entire Berkefeld infection experiments is 23 days.

By comparing the simple infection Table (XIX) with the Berkefeld infection Table (XX), it will be seen that in general the time from inoculation to death in the Berkefeld experiments is longer than in the case of simple infections. This difference between the two sets of experiments is due to differences in the concentration of the doses of the virus administered. In the Berkefeld experiments, as previously mentioned (p. 153), dilution, absorption, and film deposition play important rôles in decreasing the concentration of the virus and hence one would expect a longer period to elapse before the disease proves fatal. Table XXI represents Tables XIX and XX combined. The mean for both sets of experiments is 21 days.

Daily humidity and temperature records were kept during the entire experimental season by means of self-recording instruments for the purpose of determining whether or not these climatic factors had any influence in shortening or lengthening the period from inoculation to death. We have very carefully compared all of our records with the wilt mortality occurring in our experiments, but we have been absolutely unable to find any correlation between temperature and wilt or humidity and wilt or between both climatic factors and wilt.

On the basis of this failure to find any correlation (1915) between climatic conditions and wilt in our insectary, we would not like to exclude such a possible influence. Our records for the entire season show that the temperature and humidity were fairly constant. No extremes were reached in our insectary which was a subterranean greenhouse, so we feel obliged to continue these climatic observations in connection with wilt for another season or two before making any final statement.

Summary

(1) The chance method for obtaining healthy experimental material is absolutely worthless on account of chronic carriers.

(2) By selection a stock of caterpillars can be produced in which spontaneous wilt mortality is reduced to a minimum.

(3) Wilt is a true infectious disease.

(4) The virus of wilt is filterable through Berkefeld "N" candles.

(5) Caterpillars that have died from infection with the filtered virus are flaccid, completely disintegrated, and full of polyhedra.

(6) Microscopic examinations of the bottom sediment of centrifuged Berkefeld filtrates and platings of such filtrates show that they are sterile for bacteria.

(7) Berkefeld filtrates are free from polyhedral bodies.

(8) The nuclear inclusions called polyhedral bodies or polyhedra are by-products of the disease.

(9) We have been unable to force the wilt virus through Pasteur-Chamberland "F" filters.

(10) In our experiments the period from inoculation by feeding to death varied from 13 to 29 days. The mean for simple infections is 20 days; for Berkefeld infections 23 days. The mean for all the experiments is 21 days.

(11) An accurate record of the stock cultures is necessary for the interpretation of experimental results.

(12) Wilt seems to be transmitted from one generation to another through the egg.

(13) Certain individuals among gipsy moth caterpillars seem to be immune towards wilt.

(14) A new disease appeared in our foreign stock.

(15) A Saccromycete and a Micrococcus were isolated from cases of this new disease.

(16) The new disease appeared only during the later stages (fourth and fifth) and differ clinically and microscopically from wilt.

(17) Field observations have never revealed this new disease in our American race.

(18) Sacbrood and wilt are not identical.

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TABLE I. MORTALITY AMONG AMERICAN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
25	Berkefeld "N"	18	1 escaped 1	5 (3♂ 2♀)
25	Berkefeld "N" autoclaved	19		6 (3♂ 3♀)

TABLE II. MORTALITY AMONG AMERICAN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
20	Berkefeld "N"	6	2	12♀ ♀
20	Berkefeld "N" autoclaved	15	3	2♀ ♀

TABLE III. MORTALITY AMONG AMERICAN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
25	Berkefeld "W"	8	1 escaped 2	14 (11♂ 3♀)
25	Berkefeld "W" autoclaved	6	2	17 (14♂ 3♀)

TABLE IV. MORTALITY AMONG AMERICAN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
20	Berkefeld "W"	17	2	1 ♀
20	Berkefeld "W" autoclaved	2	6	12 (4♂ 8♀)

TABLE V. MORTALITY AMONG AMERICAN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
25	Undiluted wilt	4	21	
25	Undiluted wilt autoclaved	10	1	14 { 3♂ 11♀

TABLE VI. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" deaths in Stock of 240
10	Buchner filtrate	8		2 { 1♂ 1♀	1¼% wilt
10	Buchner filtrate autoclaved		2	8 { 3♂ 5♀	78% "other causes"

TABLE VII. MORTALITY AMONG AMERICAN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 31
10	Buchner filtrate	6		4 { 2♂ 2♀	9% wilt
10	Buchner filtrate autoclaved	2		8 ♀	0% "other causes"

TABLE VIII. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 114
10	Buchner filtrate	5	5		11% wilt
10	Buchner filtrate autoclaved	1	4	5 { 3♂ 2♀	27% "other causes"

TABLE IX. MORTALITY AMONG AMERICAN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 162
5	Buchner filtrate		1	4♀	0% wilt
5	Buchner filtrate autoclaved			5♀	1¼% "other causes"

TABLE X. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 10
12	Buchner filtrate	10	1	1 ♀	0% wilt
12	Buchner filtrate autoclaved		2	10 (9♂ 1♀)	20% "other causes"
33	Untreated		4	29 (14♂ 15♀)	

TABLE XI. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 10
12	Buchner filtrate	11	1		0% wilt
12	Buchner filtrate autoclaved	1		11 (5♂ 6♀)	20% "other causes"
11	Untreated		4	7 (6♂ 1♀)	

TABLE XII. MORTALITY AMONG AMERICAN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 42
32	Berkefeld "N"	0		23 (9♂ 14♀)	0% wilt
28	Berkefeld "N" autoclaved			28 (9♂ 19♀)	0% "other causes"
20	Untreated			20 (10♂ 10♀)	

TABLE XIII. MORTALITY AMONG AMERICAN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 42
32	Berkefeld "N"	4		28 (16♂ 12♀)	0% wilt
28	Berkefeld "N" autoclaved			28 (9♂ 19♀)	
20	Untreated			20 (4♂ 16♀)	0% "other causes"

TABLE XIV. MORTALITY AMONG AMERICAN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 30
10	Berkefeld "N"	4	3	3 { 1♂ 2♀	0% wilt
10	Berkefeld "N" autoclaved		2	8 ♀	No record of "other cause" percentage

TABLE XV. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 71
10	Pasteur-Chamberland "F"		1	9 { 4♂ 5♀	7% wilt
10	Pasteur-Chamberland "F" autoclaved		1	9 { 2♂ 7♀	17% "other causes"

TABLE XVI. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock
10	Pasteur-Chamberland "F"		1	9 { 6♂ 3♀	None left in stock
10	Pasteur-Chamberland "F" autoclaved		2	8 { 3♂ 5♀	No wilt in stock up to time caterpillars were used

TABLE XVII. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
10	Sacbrood of Bees		2	8 { 5♂ 3♀
10	Sacbrood of Bees autoclaved		1	9 { 4♂ 5♀

TABLE XVIII. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
5	Sacbrood of Bees		3	2 (1 ♂, 1 ♀)
5	Sacbrood of Bees autoclaved		2	3 (2 ♂, 1 ♀)

TABLE XIX. SIMPLE INFECTIONS, SHOWING PERIOD FROM INFECTION TO DEATH.

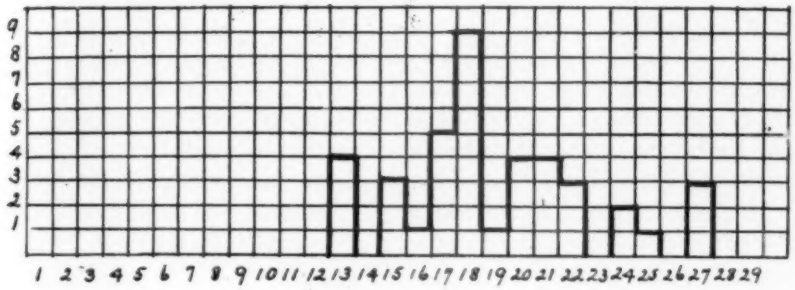


TABLE XX. BERKEFELD INFECTIONS, SHOWING PERIOD FROM INFECTION TO DEATH.

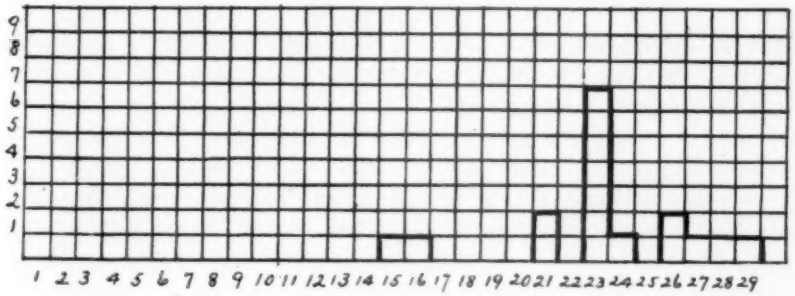
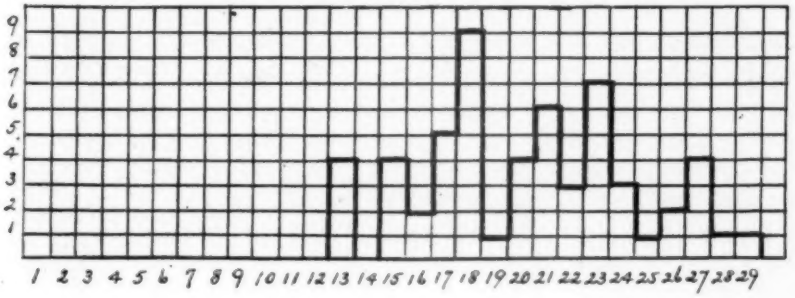


TABLE XXI. TOTAL INFECTIONS, SHOWING PERIOD FROM INFECTION TO DEATH.



PRESIDENT GLENN W. HERRICK: Is there any discussion on this paper by Dr. Chapman?

MR. T. J. HEADLEE: Has this disease been tested on the insects as well as on their food? Has it been used on a large scale in the field as a spray on the trees so that it could be fed upon?

MR. J. W. CHAPMAN: Caterpillars have been subjected to "wilt" material in various ways. It has been applied to their skin, and to their food, as well as fed to them by means of a pipette as I mentioned in the paper.

There is evidence that infection can take place when "wilt" material is applied to the caterpillars' food but no evidence that it can take place when applied to the skin.

Our own work, so far, has been confined to the study of the etiology of this type of disease. Others have attempted to use the disease in a practical way but owing to the almost universal distribution of "wilt" they have been unable to determine whether the results obtained were due to the natural spread of disease or to artificial infection.

PRESIDENT GLENN W. HERRICK: Is there any data which shows whether this disease is the same as that prevalent in Europe. Has it been known for a number of years?

MR. J. W. CHAPMAN: As to whether it is the same disease we cannot definitely state but our experimental results indicate that it is.

SECRETARY A. F. BURGESS: I think we may have to change the name of this disease. The common usage in New England in the area infested by the gypsy moth, is the "wilt" disease. Wilt diseases of plants are common in green houses and to prevent confusion it may be necessary to call this a *polyhedral disease;* then there would be no confusion.

PRESIDENT GLENN W. HERRICK: If there is no further discussion, Dr. Aldrich would like to make an announcement just at this point.

MR. J. M. ALDRICH: I am working on the Oscinidæ of grains and grasses. The last authority who classified our North American species was Mr. Becker, of Germany, in 1912; he recognized in our fauna the important European species *Oscinis frit* and *pusilla,* and I have some of the material so determined by him, now in my collection. However, there appears to be a striking difference in habit between the American species and those of Europe, which raises a doubt in my mind as to the correctness of the identifications.

Oscinis frit was known by Linnæus, its describer, to live in the larval stage in the unripe kernel of barley: the Swedes called the spoiled kernels *frits,* which gave Linnæus the specific name.

Oscinis pusilla is widely known in Europe as the oat fly, and its larvæ attacks grains of oats likewise.

I have never heard of any such attack upon barley or oats in North America, and wish that my hearers would bear the matter in mind next summer and see if any such injury can be found. Our species mine in the stems of grains and grasses, but we seem to have none that feed in kernels of grain.

PRESIDENT GLENN W. HERRICK: We have one more paper this afternoon which will be presented by Mr. Hunter.

RESULTS OF EXPERIMENTS ON THE USE OF CYANIDE OF POTASSIUM AS AN INSECTICIDE

By WALTER WELLHOUSE, *University of Kansas, Lawrence, Kansas*

In view of the number of reports, mostly favorable,[1] which have been published recently regarding the efficiency of cyanide of potassium as an insecticide against borers and plant parasites, when injected into the tissues, it seemed desirable to carry on some experiments on this question in Kansas.

Accordingly, at the instance of Professor S. J. Hunter, of the University of Kansas, and under his direction, preliminary experiments to ascertain the effect of cyanide of potassium on plant tissues and on scale insects were begun March 13, 1915.

It was thought best to use first, tender house plants, on which the effects could be seen at once. Twenty-five coleus plants infested with mealy bugs (*Dactylopius*) were secured from a greenhouse. Fifteen of these coleus plants were treated with potassium cyanide, 98 per cent pure. With a sterilized needle an incision was made in the stem of each plant, a cyanide crystal weighing from one-half milligram to three milligrams was inserted into the incision, which was immediately sealed with paraffine. In from two to three hours later the tissues bordering the hole where the cyanide had been placed began to turn dark brown and within a couple of days the stem at this point was shrunken and bent. The tissues seemed to be cauterized by the cyanide. The mealy bugs continued to grow and multiply even on the very portion of the stem where the cyanide was injected. Several plants used as checks were punctured with the needle and the puncture covered with paraffine but no cyanide was used in them. They showed no signs of injury from the treatment.

Then we determined to try the experiment on trees infested with borers. A number of different species of trees on and near the campus were selected. The trees chosen were elm, apple, pear, plum, apricot, osage orange, ailanthus, willow and pine. Over fifty trees were used

[1] "Science," Oct. 9, Dec. 11, 1914; Feb. 5, Feb. 26, 1915.

in the work. Holes varying from one to three inches deep were bored in the trunks with one-half-inch and three-eighths-inch augurs, at distances varying from a few inches to four feet above the ground. Charges of 98 per cent pure potassium cyanide, each weighing from one to ten grams, were placed in the holes and corks tightly driven into the holes. As checks, several trees were treated in exactly the same way, excepting that no cyanide was used in them. This work was done during the last of March and first of April. On May 10, the corks were removed and it was found that the cyanide had completely dissolved in the sap, no residue being present in the holes. A slight odor of cyanide seemed to be present, and the wood surrounding the interior of the holes was moist and dark brown in color. Most of the corks were replaced in the holes. On June 3, it was noted that the trees treated with cyanide seemed to have a darker, healthier foliage than their neighbors. The corks were again removed and the bark cut away from the holes in several trees. It was found that both the cambium and sapwood were dark and dry, both above and below the hole for several inches. This injury did not extend laterally from it and was just as deep as the hole. Beyond the inner end of the hole the injury had not extended inward.

On November 22, all of the trees were again examined, and the bark cut away farther from the holes. The results were quite uniform. The wood was blackened above and below the holes where cyanide had been inserted. No injury was found where no cyanide was used in the holes. A number of borers were taken alive from elm and plum trees within a few inches of the holes where cyanide had been placed. The blackened areas on trees which had been examined June 3 had increased to several times their length on that date. This black wood always occurred as a streak the width of the hole and followed the direction of the grain of the wood above and below the hole. In several cases the cambium and inner bark had dried and had been pushed out from the black streak and a callous growth was starting from both sides beneath the bark over the entire length of the streak.

This shows that the tree is injured only above and below the opening in which the cyanide is placed and that the healthy wood on both sides is attempting to heal the wound caused by the cyanide. No dead insects were found but in some of the holes left uncorked since June sow bugs were found to be breeding.

Dr. J. H. Merrill of the Kansas Agricultural College has been carrying on some experiments along this line. Professor Dean advises me that the results obtained were similar to those just given. The effects on the trees treated, as noted by both departments, was that the foliage became a distinctly darker and richer green after the introduction of the cyanide.

1.

2.

3.

4.

POTASSIUM CYANIDE INJECTIONS

1, Coleus pierced but no KCN injected; 2, Cyanide injected and living Mealy Bug; 3, Dark streak in apple caused by KCN; 4, Living Elm Borers after KCN injection.

PRESIDENT GLENN W. HERRICK: I believe all this trouble began near Professor Kellogg's territory.

MR. V. L. KELLOGG: I might say that the stimulus may have come from Stanford University but not from the Stanford entomologists. A great many letters came to the Department of Entomology asking for information, but a professor of physics took up the subject on his own initiative.

SECRETARY A. F. BURGESS: I think it has been a long time since Professor Kellogg has attended one of our meetings and I am sure we are all pleased to see him here.

I hope he will take to the coast with him the best wishes of the Association to the entomologists of that region.

MR. V. L. KELLOGG: I thank you very sincerely.

MR. WM. MOORE: I was particularly interested in this paper as we carried out practically the same work last fall and published in *Science* the original discussion.

We found that the reason for the failure to kill the mealy bugs was due to the cyanide not traveling up the plant through vascular bundles but through the intercellular spaces. In trees it travelled through the old trachea. I think it went about 8 feet in one apple tree. We then cut down the tree and determined the cyanide by chemical test. In one tree we bored a number of holes and inserted little glass tubes containing distilled water. It was interesting to note that the cyanide happened to miss every one of these holes in the tree. It shows you really how much chance you would have with the wood-boring insects.

PRESIDENT GLENN W. HERRICK: No further discussion?

We will have a joint session tomorrow morning with the Entomological Society of America to hear the papers by Professor Webster and Dr. Howard.

Adjourned, 4.30

MORNING SESSION

Thursday, December 30, 1915, 10.00 a. m.

The Association met in a joint session with the Entomological Society of America, Prof. V. L. Kellogg, President of that association in the chair.

As previously arranged, the papers prepared by Prof. F. M. Webster and Dr. L. O. Howard were to be presented at this session. Owing to the sudden illness of Professor Webster his paper was read by Dr. E. P. Felt. (Withdrawn for publication elsewhere.)

Two papers were then presented by Dr. L. O. Howard.

ON THE HAWAIIAN WORK IN INTRODUCING BENEFICIAL INSECTS

By L. O. Howard

There have been several efforts in the past few years to bring together some account of the experiments in different parts of the world with the practical use of the natural enemies of injurious insects. Probably the first of these was contained in the writer's paper on "The Economic Status of Insects as a Class," the address of the retiring President of the Biological Society of Washington, January 18, 1899, afterwards published in *Science*, new series, IX, No. 216, pp. 233–247, February 17, 1899, and afterwards republished in the Annual Report of the Smithsonian Institution for 1898, pp. 551–569 (Washington, 1900). The second was probably the writer's paper presented before the Massachusetts Horticultural Society January 13, 1906, and published in the Transactions of that Society for 1906, Part I, pp. 11–19 (author's abstract, Boston, October, 1896).

In 1907 was published Paul Marchal's important paper entitled "Utilisation des Insectes Auxiliaires Entomophages dans la Lutte contre les Insectes nuisibles à l'Agriculture," which appeared in the *Annals* of the National Agronomical Institution (Superior School of Agriculture), Part II, Vol. VI of the Second Series, pp. 281–354. The writer translated this paper, and it was published in *Popular Science Monthly*, Vol. LXXII, April and May, 1908, pp. 352–370 and 406–419. In this admirable summary, Marchal mentioned the work of the importation of the natural enemies of the sugar cane leafhopper by the Sugar Planters' Association of Hawaii, but was apparently uninformed at that time as to the success or non-success of the work.

In the following year, 1908, Dr. F. Silvestri visited the United States and Hawaii, and in 1909 published in the *Bulletin* of the Society of Italian Agriculturists another important summary, included in his account of his investigations, under the title "Sguardo allo Stato attuale dell'Entomologia Agraria negli Stati-Uniti del Nord America e Ammæstramenti che possono derivarne per L'Agricoltura Italiana." A translation of a large portion of this will be found in the Hawaiian *Forester and Agriculturist* for August, 1909 (Vol. VII, No. 8). Having spent a month on the Hawaiian Islands in intimate association with the entomologists at the Sugar Planters' station, Silvestri was able to give a rather full account of the work done there, and praised it highly.

A later general summary of the world work of this kind will be found in the first 46 pages of Bulletin 91 of the Bureau of Entomology,

"The Importation into the United States of the Parasites of the Gipsy Moth and Brown-tail Moth: A Report of Progress with some Consideration of Previous and Concurrent Efforts of this Kind," by L. O. Howard and W. F. Fiske (Washington, 1911). In this account some space is devoted to the search for parasites of the sugar cane leaf-hoppers in Hawaii, with the final statement that "The practical results of these importations seem to have been excellent. There seems no doubt that the parasites have been the controlling factor in the reduction of the leaf-hoppers."

The latest to be published is the chapter entitled "Die biologische Bekämpfung," in K. Escherich's book, "Die angewandte Entomologie in den Vereinigten Staaten," published by Paul Parey in Berlin, 1913; but in this account the Hawaiian work is not mentioned.

The Hawaiians themselves have not bragged about their achievements. They have published bare statements of facts with technical descriptions of imported species, but have shown themselves aggrieved by statements made by Froggatt in his account of his journey around the world during which he spent a month on the islands and they have published, as just indicated, a translation of a large, part of Silvestri's commendatory paper. Recently, however, they have seemed to be more inclined to tell the world exactly what they have done and to welcome the favorable and even enthusiastic comment which must necessarily follow a widespread knowledge of their achievements. Mr. O. H. Swezey, for example, in an excellent, straightforward, and at the same time modest paper which he read before the meeting of the Association of Economic Entomologists at Berkeley, California, during the first week of last August (published in the JOURNAL OF ECONOMIC ENTOMOLOGY, Vol. 8, No. 5, October, 1915), has put the entomologists of the world in possession of many new facts which were unknown to them before.

But still, enough has not yet been said, and the writer satisfied himself by a visit during August, last, to Oahu, by observation, and by interviews with the scientific men of the island and with the practical men of affairs, that Hawaii has seen a most extraordinary series of successful experiments in the introduction of beneficial insects which has in toto far excelled anything of the kind that has been done elsewhere in the world and which has resulted in an immense monetary saving. There can be no doubt of it.

THE SUGAR CANE LEAF-HOPPER AND ITS IMPORTED PARASITES

The sugar cane leaf-hopper of Hawaii (*Perkinsiella saccharicida* Kirkaldy) appears to have been introduced with seed from Australia about 1898.

It was first found harmful to sugar in 1902. It spread rapidly, and in 1903 damaged the crop to the extent of three millions of dollars. That year Kœbele came to the United States to look for parasites.

In 1904 Kœbele and Perkins went to Australia; got more than one hundred species of parasites of leaf-hoppers, and although failing with their first consignment sent in cold storage from Cairns, later shipments from Bundaberg were successful. They were reared in confinement and liberated in cane fields.

The year 1904 showed enormous loss from the leaf-hopper on many plantations. In 1906 certain of the parasites began to multiply very rapidly.

In 1907 one very large plantation, owned by the Hawaiian Agricultural Company, whose crop had dropped from 10,954 tons in 1904 to 1,620 tons in 1905 and to 826 tons in 1906, made the next year 11,630 tons almost entirely as the result of the parasite introduction.

Silvestri visited the islands in 1908 and reported with enthusiasm on the results of the introductions.

During August, last, the situation with regard to the sugar cane leaf-hopper on the island of Oahu was almost perfect. The canes were not damaged in any respect so far as I could see. The leaf-hoppers were still present, but in insignificant numbers; where they had oviposited their eggs were almost invariably parasitized either by Paranagrus or Ootetrastichus.

I was told that there is an occasional reviving of the leaf-hoppers in numbers, following the destruction of parasites by trash-burning, and that, at that time, on one large plantation on the island of Hawaii, 1,000 acres was so badly infested that a yield of only one-half a normal crop was expected; but these recrudescences are and probably will be fugitive.

No other leaf-hopper parasites were seen. Some of the parasites of the adults, notably Haplogonatopus (a Dryinid), I was informed, still exist on the islands.

The Sugar Cane Borer and its Parasites

The sugar cane weevil borer, *Rhabdocnemis* (*Sphenophorus*) *obscurus*, has been a pest on the islands for very many years.

After the success of the egg parasites of the leaf-hopper in 1904–5, the Planters' Association began to search for parasites of the weevil. F. Muir started on an exploring trip, and in 1908 found a Tachinid fly (*Ceromasia sphenophori* Villeneuve) at Amboina in the East Indies parasitizing a weevil infesting sago palms, sometimes destroying 90 per cent of the borers, the weevil being probably only a geographic variety of the sugar cane species.

During the summer of 1908 efforts were made to send this tachinid to Hawaii by means of a relay breeding station at Hong Kong, but failed. Later, in British New Guinea, Muir found the same tachinid destroying a borer in sugar cane, identical with the Hawaiian species, and destroying a high percentage. He succeeded in breeding it in cages. He was taken down with typhoid, and on arriving at Brisbane, Australia, was forced to go to a hospital. His parasite cages were sent on to Honolulu, but, wanting proper care, the parasites died.

After his recovery he met J. C. Kershaw, an entomologist whom he had previously met at Macao, China, at Brisbane in January, 1910. Kershaw prepared cages at Moresby, North Queensland, and Muir went to New Guinea where he collected puparia of the tachinid and sent them to Kershaw. The latter placed these in cages containing the prepared sugar canes containing numerous borer larvæ.

Muir continued to send puparia until Kershaw had the tachinids satisfactorily breeding, when he joined him, and, taking fresh puparia from the cages, went to Fiji where another breeding station was established. When this was successfully done, Kershaw abandoned the cages in Queensland and went to Fiji with more puparia. When he arrived, Muir went to Honolulu with tachinids, leaving Kershaw in Fiji where he remained a few more weeks and then came on to Honolulu with additional parasites.

Muir arrived in Honolulu with living parasites in August, 1910, and Kershaw arrived the following month. Part of the parasites were liberated and others retained in breeding cages.

The breeding continued for two years in the cages; the colonies were liberated on sugar plantations as rapidly as they were available. They bred continuously, each generation requiring about six weeks, and there were about six generations a year.

After six months they were found established and increasing in plantations where the first liberations were made, and in a year spread to all parts of these plantations, sometimes over a distance of five miles.

In 1914 Swezey reported (JOURNAL OF ECONOMIC ENTOMOLOGY, December 14, 1914) that they were established almost entirely throughout the sugar cane districts of the islands.

Prior to the introduction of parasites, hand collecting had been practiced on some plantations. On one plantation, in 1913, 27,010 ounces were collected; in 1914, on the same plantation, only 3,440 ounces were collected, showing a reduction of over 87 per cent.

In August, 1915, I found the borer rare on Oahu. In no case did I find a living larva. Mr. Swezey and Mr. Osborn found for me a number of burrows, but in every case when they were opened the larva had been destroyed and the puparia of the tachinid were present.

As the result of this importation, there has been a very great increase in the sugar yield per acre. The gain runs into the hundreds of thousands of dollars.

The adult tachinid places her eggs at openings in the rind of the cane where the borer larvæ feeding inside have come to the surface. The maggots find the borer larvæ in the channels, penetrate the body and kill the host when it is about ready to pupate. From one to a dozen maggots may thrive in one borer larva, but one is sufficient to kill it. The puparia are found in the fibrous cocoon made by the full-grown borer larva. The flies on issuing make their way through the cocoon and out of the cane through the hole which the borer larva had previously made.

The Mediterranean Fruit-Fly and its Introduced Parasites

The Mediterranean fruit-fly has been present in Hawaii since some time prior to 1910, and has practically stopped the growing of fruit except pineapples and bananas, although some sound mangoes and alligator pears are still raised.

On account of the occurrence of enormous quantities of wild guava bushes all over the mountains, the extermination of the fly or even its great reduction in numbers seems to be impossible. The destruction of the fallen fruit afforded little relief. Poisoning experiments, although somewhat successful, could not control, on account of the enormous wild supply.

Silvestri, by his favorable report on the work of the Sugar Planters' Association in the introduction of parasites of the leaf-hopper, achieved the good will and admiration of the Hawaiian people, notably Mr. W. M. Giffard, Chairman of the Entomological Committee of the Sugar Planters' Association and President of the Hawaiian Board of Agriculture and Forestry. He therefore asked Silvestri to search for parasites of the fruit-fly and to introduce them into Hawaii. Silvestri started July 25, 1912, and visited the Canary Islands, Senegal, French Guinea, Southern Nigeria, Gold Coast, Dahomey, Congo, Angola, and South Africa; then, by way of Australia, he went to Honolulu, arriving May 16, 1913.

He brought with him from West Africa, having continuously reared them through the journey, 300 specimens of *Galesus silvestrii* Kieffer, 500 specimens of *Dirhinus giffardi* Silvestri, 12 specimens of *Opius perproximus* Silvestri, 5 specimens of *Opius humilis* Silvestri, and 4 females and 3 males of *Diachasma tryoni* Cameron. The rearing of these was begun by Mr. D. T. Fullaway until September 30, and then by Mr. J. C. Bridwell from October 1 to December 31, 1913. It was found not very difficult to rear some of them in confinement. The

Galesus and the Dirhinus, both pupa-parasites and received in the greatest numbers, have not yet become established. They have been put out in quantity but have not been recovered in the open. Whether the character of the soil is the trouble, or whether they are all destroyed by the fire ant is a question.

The Braconids were discouraging from the start. *Opius perproximus* failed. *Opius humilis* and *Diachasma tryoni* were divided. Four females of Diachasma and three females of Opius were liberated in the district of Kona. Those retained in breeding cages were lost.

Now comes the extraordinary thing. From the insignificant number of seven females of the Diachasma and Opius liberated in Kona, both species have become established! Both are larva-parasites, and were rediscovered by Mr. Giffard and Doctor Back. An examination made by Back and Pemberton in the summer of 1914 indicates percentages of parasitism as high as 85 in larvæ from coffee berries grown in the Kona district, 97.8 per cent in larvæ from coffee berries at Lanihau and high percentages in other fruits at other places.

The Earlier Introductions

The earlier introductions of parasites and beneficial insects against injurious insects, made by Kœbele before the outbreak of the sugar cane leaf-hopper, have been rather fully considered in Mr. Swezey's paper and elsewhere. Very many of them undoubtedly did excellent work. In spite, however, of the large numbers of enemies of mealy-bugs that were introduced at that time, outbreaks are frequent though not serious; and, although efficient parasites were introduced for leaf-rollers and the latter are not now very injurious, outbreaks occasionally occur. This, however, is quite to be expected, and in any consideration of the value of imported parasites we must never expect extermination but a reduction to comparatively non-injurious numbers with an occasional increase to some extent.

In the case of none of these early introductions was there sufficient study made of the intimate biology of the species introduced, and in fact the most careful study should be made now of the intimate life-history of the recently introduced parasites, and especially of those which are still coming in from Mr. Fullaway. Some of this work I hope Mr. Timberlake will be able to do.

Just why they have been able to accomplish so much is at first glance rather hard to understand. As early as 1897 Mr. R. C. L. Perkins, writing in *Nature* (Vol. 55, No. 1430, March 25, 1897), and referring to the successes of the importations of many species by Kœbele for the purpose of destroying various crop pests, wrote as follows:

It becomes natural to ask why the success of the imported beneficial insects has been so pronounced here, while in other countries it has been attained in a comparatively small measure. The reason, I think, is sufficiently obvious. The same causes which have led to the rapid spread and excessive multiplication of injurious introductions, have operated equally on the beneficial ones that prey upon them. The remote position of the islands, and the consequently limited fauna, giving free scope for increase to new arrivals, the general absence of creatures injurious to the introduced beneficial species, and the equability of the climate, allowing of almost continual breeding, may well afford results which could hardly be attained elsewhere on the globe. The keen struggle for existence of continental lands is comparatively non-existent, and, so far as it exists, is rather brought about by the introduced fauna than by the native one.

In commenting upon Mr. Perkins's paper, the writer, in his address on "The Spread of Land Species by the Agency of Man," said: "Mr. Perkins's reasons are all good, but he has not mentioned one prime reason of success, and that is that the most successful of the imported species have come from another portion of the same great faunal region, while others have been received from the region most closely allied, viz. the oriental." This was in connection with a discussion as to the chances of acclimatization of insects brought from different life zones.

In connection with this discussion, by the way, I concluded: "It is on the degree of simplicity of its life—the degree of simplicity of its natural environment as a whole—that the capacity of a species for transportation and acclimatization, even in a parallel life zone, depends." Mr. H. S. Smith recently, in a letter in which he quotes this sentence, very aptly writes: "It seems to me that the degree of simplicity of the new environment is quite as important. If the species introduced into Hawaii had encountered the complex relation that *Apanteles fulvipes* did in New England, where it was attacked by eighteen different species of secondaries as well as several predators during the first generation, there might have been a different tale to tell!"

It must be pointed out in conclusion that while conditions in Hawaii are extremely favorable for the reasons which Dr. Perkins formulated so early in the game, the men in control of the work were fortunate in themselves in the first place, and in having Mr. Giffard among them, and fortunate in being able to financially support any promising measure; and were fortunate, also, in having Mr. Kœbele and Dr. Perkins at hand; and were fortunate later in being able to add to their forces such men as Swezey, Muir, Silvestri, and Osborn, and now Fullaway; and at the present moment Timberlake, with his admirable technique and broad knowledge, is on the Pacific on his way to take up parasite work under the combined auspices of the Sugar Planters' Association

and the Territorial Board of Agriculture. All the possible requirements for successful work have thus been filled, namely the most favorable climate (permitting continuous breeding throughout the year), the most favorable conditions of cultivation, a small number of crops, a restricted and simple fauna, a highly intelligent body of men in control, with plenty of means, and an altogether admirable force of scientifically trained employees. As the French would say, *Que vouliez vous encore?*

What we shall want later is a complete account of the whole work from Mr. Giffard or Dr. Perkins or Mr. Muir or Mr. Swezey. The work has been most notable and should have its written history available to all.

FURTHER NOTES ON PROSPALTELLA BERLESEI HOW.

By L. O. Howard

The little Aphelinine parasite known as *Prospaltella berlesei* has become a creature of much international and practical importance, and its name in various combinations, not only as a noun but as a verb as well, has made its entrance into the Italian and Spanish languages, and bids ultimately in these same combinations to enter the English language.

Originally found by Berlese in Florence, issuing from lilac twigs infested by *Diaspis pentagona* sent from Washington by Marlatt at the writer's request in May, 1906, this parasite was sent back to the writer in Washington, was found to be new, and was described by him as *Prospaltella berlesei* in an article on the parasites of *Diaspis pentagona* in *Redia*, Vol. III, part 2, and in the *Entomological News* for October, 1906, pp. 292–293. Sendings of parasitized scales from Washington to Florence were continued during 1906, 1907 and 1908.

Berlese's continuous success in rearing and colonizing this parasite on mulberry trees affected by the scale has been reported from time to time, notably in an article in the Journal of Economic Entomology for August, 1912, pp. 325–328, translated by the writer from a French abstract of Berlese's report drawn up by Dr. Caterina Samsonoff.

During the past year Professor Berlese has published in a long article in *Redia* (X, Parts 1 and 2, May 20, 1915, pp. 151–218) a summary account of the warfare in Italy against *Diaspis pentagona* which at the beginning of the present century threatened the extinction of the silk industry of Italy through the destruction of the mulberry, of the early laws enacted to enforce the mechanical and chemical fight

against it, of the introduction and spread of the Prospaltella and of its eminent success, until in 1914 a large part of Italy was relieved from the danger, the old laws for its treatment had been canceled, and quarantine on the part of France against Italy had been modified.

Thus the practical introduction and colonization of this Prospaltella in Italy by Berlese has proved to be one of the greatest of the successful efforts of this kind yet carried out.

Attracted by this Italian success, the Prospaltella has recently been introduced from Italy into Switzerland and Spain, and at an earlier date into Uruguay; Argentina, Peru, and Chile—in Uruguay and Argentina from both Italy and the United States, to be used against *D. pentagona;* and into Peru and Chile from the United States, to be used against other species of Diaspinæ. A certain amount of success has been achieved in the Argentine Republic and in Uruguay, and in the former country a national Prospaltella commission has been founded, under the Ministry of Agriculture, for the purpose of handling the dissemination of the parasites. It is entitled "Comision Nacional Para Propagar la Prospaltella Berlesei How.," and Señor F. A. Barrœlavena is the president.

In both Italy and Uruguay the Italian and Spanish equivalents of the verb *to Prospaltellize* and the noun *Prospaltellization* have apparently come into general use.

Berlese and Marlatt are probably correct in their belief that *Diaspis pentagona* is an indigene of tropical oriental countries. Marlatt writes concerning this species: [It] "is common to all eastern Asia, including Japan and the East Indies, and undoubtedly, from its wide distribution and local occurrence in most out-of-the-way districts, is a native of this region and has been spread about in times so remotely past as to be beyond determination. It is probably a tropical species which has worked northward until practically the whole region as far as Peking, China, and the north island of Japan has been covered." [1]

Unlike most Aphelinines, *Prospaltella berlesei* seems to be rather specifically connected with *Diaspis pentagona*, whereas most of the group may be reared from several Diaspine hosts. It is probable, therefore, that this parasite is also of oriental origin, and in fact the whole genus Prospaltella may very possibly be of tropical oriental origin. Of the twenty-two species which have been described, six have been described from the United States, five from Italy, two from Spain, one from Germany, one from Porto Rico, one from Peru, one from Hawaii, one from India, one from China, one from Java, and three from Australia, but it must be noted that all have been described within the past twenty years, and, as has been frequently pointed out, so great

[1] Bulletin 37, new series, Division of Entomology, p. 78.

has been the commercial carriage of Coccidæ upon plants imported from one country to another that it is no longer possible to ascertain the original country of the majority of the species, and naturally the same may be said for their parasites. In fact, as I have elsewhere pointed out,[1] the entire Aphelinine fauna of the United States was radically changed by these accidental importations in the twenty years between 1880 and 1900. *Prospaltella berlesei* occurs in Japan, as was ascertained by Berlese after its discovery in Italy from twigs sent from Washington. In Washington its host was first discovered about 1894. No effort was made to rear parasites from it until the lilac twigs bearing it were sent to Berlese in 1906, but the parasite may have come in from almost any part of the world, since plants were being brought to Washington from many points. The manner of the introduction of the scale in Washington is unknown, and there are no data for even a respectable theory. The same must be said of the parasite.

Berlese assumes that: "This species was imported to Washington by Marlatt without his knowledge with material gathered in the extreme east" (free translation). This assumption is purely theoretical, and, as a matter of fact, is groundless. I myself examined all the parasites reared from the Coccid material sent in by Marlatt, including that reared from *Diaspis pentagona* shipped as food for *Chilocorus similis*, and, as Marlatt has pointed out (loc. cit.), the only species reared from this scale were *Aphelinus fuscipennis* How. and *Aspidiotiphagus citrinus* (Craw.), the latter being the most numerous. There is no chance that the Prospaltella was unknowingly imported by Marlatt.

Professor Berlese is greatly to be congratulated on the successful outcome of his intelligent and perservering and arduous work in this great experiment, and it is a great satisfaction to the United States Department of Agriculture and to American workers generally that the United States was able to assist somewhat in return for the many courtesies shown to workers in the Department and in the country generally by Berlese and his Italian colleagues.

The joint session then adjourned. The Association of Economic Entomologists were then photographed on the front steps of the Botany and Zoölogy Building. They reconvened in another room and a paper was presented by Mr. J. R. Parker.

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[1] *Bulletin de la Société entomologique de France*, 1911, No. 12, pp. 258–259.

THE WESTERN WHEAT APHIS (BRACHYCOLUS TRITICI GILL.)

By J. R. Parker, *Bozeman, Mont.*

Historical

The Western wheat aphis was originally described by Professor Gillette in *Entomological News* for December, 1911. Concerning it he remarks, "This is seemingly a rather rare species occurring upon grasses and has been taken several times by L. C. Bragg upon the leaves of blue stem (*Agropyron glaucum*) and upon wheat during the summer months in the vicinity of Fort Collins."

In Montana this insect first attracted attention in 1910 when reports came to the experiment station that a plant louse was destroying winter wheat in a few localities in Fergus County. An investigation of these reports brought out the fact that more injury was being done than we had believed a grain plant louse capable of doing. In one instance a grower who had 700 acres of wheat estimated his loss due to wheat aphis at 5,000 bushels. Another grower had 80 acres of winter wheat so badly injured that no attempt was made to harvest it.

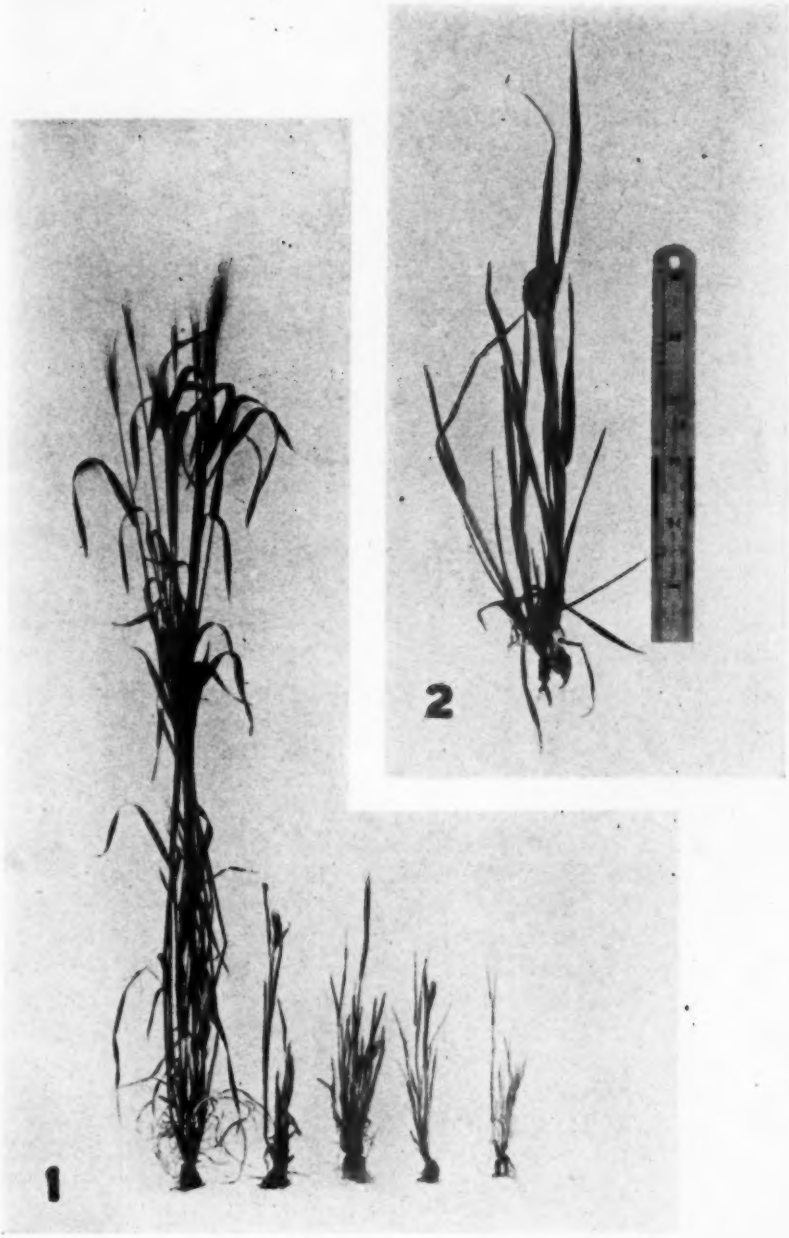
Since 1910 the Western wheat aphis has become increasingly abundant in Fergus County and has appeared in injurious numbers in several other counties. During the past two seasons in Montana, with the exception of the army cutworm (*Chorizagrotis agrestis* Grote), it has ranked as the most destructive insect pest of winter wheat.

Since economic entomological literature contains no account of the Western wheat aphis, and because of the great economic importance of its host plant, this paper has been prepared to bring together some of the facts which have been learned about this new pest of wheat.

Description

Technical descriptions of the various forms of this species have been published by Professor Gillette in *Entomological News*, Volume XXII, pages 441–442. In this paper only a brief general description will be given.

The wingless viviparous female, which is the form most frequently seen, is peculiarly shaped, being unusually long and narrow for an aphid. It is about 2 millimeters in length, and .6 of a millimeter in width. The general color is a pale yellowish green, but this is generally hidden by a powdery white coating. The body appendages are all somewhat reduced: the cornicles can be seen only with the aid of a lens; the antennæ are less than half the length of the body and the legs are quite



Western wheat aphis: 1, Comparison of normal and infested plants; 2, Characteristic type of injury.

short. The peculiar long and narrow body with its covering of white powder will easily distinguish this form from other aphids commonly found upon wheat.

In the winged viviparous female the head, antennæ and thorax are black, while the abdomen is light green. The body is powdered with a white secretion, but to a less extent than in the wingless female. The body is also shorter, the length averaging about 1.5 millimeters. The cubital vein of the wing is twice forked. This form may be distinguished from other grain aphids by the cornicles, which are greatly reduced and appear only as mere rings slightly raised above the surface of the body.

The oviparous female is similar in appearance to the wingless viviparous female.

The male is wingless, only about half as long as the female, less densely clothed with white powder and is somewhat lighter in color.

The eggs are pale yellow when first laid, but soon change to green and after a few hours become shining black.

Character and Extent of Injury

Wheat plants infested with the wheat aphis have a characteristic appearance which is easily recognized after having once been seen. On small plants the first indication is a thickening and broadening of the leaf blade. Soon longitudinal, whitish stripes appear and these frequently become pinkish in the later stages. Leaves of infested plants in late fall and early spring have a fleshy and whitened appearance as compared with the slender dark green leaves of uninfested plants. One or two aphids hidden from sight and feeding in the yet unexpanded basal portion of the leaves are sufficient to bring about the characteristic appearance described above. These soon increase, however, and the entire upper surface of the leaves is frequently covered with lice. No curling of the leaves has been observed in the fall or early spring. Heavily infested plants make little or no growth and by midsummer are generally dead. Plants less heavily infested sometimes stool out and eventually send up a twisted central stem bearing a deformed head. A short time previous to heading, the leaves surrounding the central stem generally become tightly curled and as a result the head has difficulty in pushing up through them and very frequently forces its way through the side of the boot or sheath. The peculiar twisting of the terminal leaves which occurs in this stage is quite characteristic, the leaf twisting spirally in one direction for a short distance and then curling in the opposite direction. The deformed heads seldom reach a height of over ten inches from the ground and, as a rule, do not ripen any grain.

Wheat aphis injury is more commonly found in circular areas from 10 to 50 feet in diameter, distributed in an irregular manner about the field. In May these spots are noticeable because of the stunted and peculiar appearance of the small plants; in June many of the plants are wilting and yellowing, while a few are sending up curled stems bearing deformed heads; by midsummer practically all the wheat plants are dead and the area is covered with a growth of weeds. In some cases entire fields of wheat have been completely destroyed; such instances are not common, but are occurring more frequently each year.

Other Host Plants

Barley is the only grain crop besides wheat which thus far is known to be injured by the wheat aphis. Oats seem to be disliked and are not harmed even when growing in the midst of infested wheat.

Blue joint grass (*Agropyron occidentale* Scribn.), when growing in and around the edges of infested wheat fields, is always heavily infested and is probably the native host plant. However, an extended search for the wheat aphis upon blue joint grass some distance from infested grain fields has not as yet revealed it in such localities. Near infested wheat, the wheat aphis has also been found upon cheat (*Bromus secalinus* L.), spear grass (*Stipa comata* F. & R.) and timothy (*Phleum pratense* L.).

Seasonal History and Habits

The winter is passed in the egg stage upon fall seeded wheat, volunteer grain and grasses. The eggs hatch early in April and the resulting stem mothers become adults and begin producing young in about two weeks. About June 1, a few winged forms appear and fly to new host plants. By June 15, winged migrants are very plentiful and continue in increasing numbers until about July 1, when they begin to decrease in number. In Montana no winged forms have been seen after August 15, and it appears that the period of greatest activity in migration in normal seasons occurs from about June 15 to July 1. This period is of particular importance in relation to control measures. The winged migrants do not settle upon large plants even though they are green and succulent, but are apparently prompted by instinct to search out smaller plants which will afford food for a longer period. Summer fallowed fields plowed previous to June 15 and then allowed to grow up to grasses and volunteer grain offer the ideal conditions which the migrants are seeking. Scattering plants spring up and, having a large area from which to draw moisture, remain green and succulent until killed by heavy frosts in the fall. Upon such plants, wheat and blue stem primarily, the wheat aphis passes the summer.

During the hottest summer weather coccinellid and hymenopterous parasites greatly reduce their numbers, but as cold weather comes on the parasites lessen their activities and the aphids become so abundant that their host plants are overloaded, forcing the plant lice to migrate in search of fresh food. By this time the new crop of fall wheat is well started and again the migrants find the ideal conditions which they are seeking. Observations were made in infested grain fields during the first week of November of the present season, and, whenever an infested stool of volunteer wheat was found, the wingless lice could be seen crawling away from it in all directions. Thus one good-sized stool of volunteer grain will reinfest much of the new crop within a radius of 10 to 25 feet and sometimes to greater distances. It is a significant fact that, whenever an area in which the wheat has been destroyed by the wheat aphis is examined in the spring, the old dried volunteer plants from which the infestation started can always be found.

About October 15, true males and females are produced and egg-laying is carried on until very late in the fall. On December 2, 1914, wheat plants were seen which were covered with egg-laying females even though the thermometer had registered 11 degrees below zero in that vicinity on November 15. The eggs are deposited for the most part upon the leaf blade upon which the female is feeding, but are also placed upon dried stems and upon the soil. The old volunteer plants and bunches of blue joint have upon them the greatest number of eggs, but many are also laid upon the small fall wheat plants by the crawling migrants.

Control

Clean Tillage of Summer Fallowed Fields.—The life-history and habits as just discussed would naturally suggest clean tillage of summer fallowed wheat land as the most feasible method of control. That this is the right method may be emphasized by the statement that no wheat aphis injury has ever been found except on summer fallowed land where volunteer grain and grasses have been allowed to grow. Fall wheat on sod land in heavily infested localities has never been injured even when adjoining fields have been completely destroyed.

It is a very simple matter to advise that the wheat aphis can be completely controlled by keeping summer fallowed fields absolutely free from volunteer grain and grasses, but it is often a difficult and expensive proposition for the farmer to put the advice into practice. The ordinary method of procedure in the handling of summer fallowed wheat land in Montana is to plow in the spring and to follow with a varying number of diskings to kill vegetation and to conserve moisture.

But even if repeated cultivations are give with the ordinary disk harrow, some volunteer wheat and much blue joint grass is very likely to escape and only a few such plants are necessary to bring about an infestation of wheat aphis in localities where it is abundant. Moreover, in the most heavily infested districts of Fergus County, soil and climatic conditions are such that frequent diskings during the summer months are not desirable, for when the soil becomes finely pulverized it blows and drifts badly the following winter. Several of the less common methods of obtaining clean summer fallowed fields are, therefore, discussed with particular reference to their bearing on wheat aphis control.

Use of Special Tools.—It has already been said that the ordinary disk harrow allows some vegetation to escape. There are now on the market tools of the duck-foot cultivator type which are composed of sets of overlapping V-shaped knives which will cut all vegetation just below the surface of the soil. These are much more efficient than the disk as destroyers of vegetation, are of light draft and do not pulverize the soil as much as the disk harrow. They have the disadvantage of not working well in rocky ground.

The use of the hand hoe in destroying vegetation which has escaped the first diskings is practiced by some growers, who report it a cheaper and more thorough method than to continue the disking.

Late Plowing.—In discussing the wheat aphis with many growers, a surprisingly large number have remarked that fields plowed early, that is, in April and May and up to June 15, were severely injured, while nearby fields, plowed after June 15, were uninjured. One man started plowing on May 15, but at that time plowed only an area of a few rods wide around the field. On July 4, plowing was resumed and carried to a finish. The following spring the early plowed area was badly injured by the wheat aphis, while the late plowed area was practically uninjured. Such cases are easily explained. On the early plowed land volunteer grain and grasses have an opportunity to start up during the season of rainy weather that follows plowing, thus bringing about inviting conditions to the migrants which are flying in June and July. In late plowed fields all volunteer grains and grasses that have started during the rainy season are turned under and the field is left bare during the migration period.

Some growers disk the stubble early in the spring and then do not start plowing until after June 15. The disking has a tendency to hasten the germination of grains and weed seed and makes plowing easier.

Some of the most successful growers plow twice, a shallow plowing in early spring and a deeper plowing after June 15, well toward the close of the spring rains. Such fields are remarkably free from vol-

unteer grains and grasses and are said to give increased yields over once-plowed fields. No wheat aphis injury has ever been seen on double-plowed fields.

Late plowed fields can undoubtedly be kept free from vegetation with much less labor than early plowed fields and this practice, when it can be carried on without interfering with economic farm practices, is recommended in districts where the wheat aphis is abundant.

PASTURING.—Some farmers allow a small band of sheep or other stock to graze on summer fallowed land and where vegetation is kept down in this manner wheat aphis injury has not been noticed.

In November of the present year, an 80-acre field of winter wheat was seen which was so badly infested with wheat aphis that there seemed to be absolutely no hope of the crop maturing if left as it was. The field was everywhere dotted with clumps of volunteer wheat, from which females were migrating to the new crop, and already nearly every young wheat plant was infested with egg-laying females. A band of 1,500 sheep was turned into this field and in a short time had grazed off nearly all vegetation. Whether a new growth will be produced that will be free from wheat aphis remains to be seen, but it is certain that a great majority of the plant lice and their eggs have been destroyed and this method gives some promise in the handling of fields that are already badly infested.

CROPS THAT MAY BE SOWN ON GROUND WHERE GRAIN HAS BEEN DESTROYED BY THE WHEAT APHIS.—Wheat aphis injury generally appears early enough in the spring so that destroyed areas may be seeded to spring grains or other crops.

Spring wheat may be safely planted if infested wheat plants are first plowed under. This was tried in several fields during the past season and in no instance was the spring crop injured. Spring wheat and barley drilled in among infested plants have been badly injured and this practice is considered decidedly unsafe.

Probably the safest and easiest crop to put in on such land is oats upon which the wheat aphis has never been seen to feed. One grower whose 80-acre field of fall wheat was completely infested with aphis in the spring merely drilled in oats without previous preparation of the soil. The young oats grew side by side with the heavily infested wheat, but were never attacked and at harvest the crop yielded 50 bushels to the acre. By early summer all of the wheat in the field had been killed.

This concluded the reading of papers for the meeting and after the usual closing business session the meeting adjourned.

A. F. BURGESS, *Secretary.*

Proceedings of the Fifth Annual Meeting of the Section on Apiary Inspection

The Fifth Annual Meeting of Apiary Inspectors was called to order by the Chairman, Dr. E. F. Phillips, at the Southern Hotel, Columbus, Ohio, Monday evening, December 27, 1915.

The meeting showed the largest attendance of any yet held. This was undoubtedly due to the fact that it did not conflict with the meeting of any other section and was held at the hotel headquarters of the Association.

The principal things brought out in the address of the Chairman and in the other papers presented were fully discussed and led to the following action by the Section:

It was moved by Dr. Headlee and carried by vote, that it is the sense of this Section that the Association of Economic Entomologists admit apiary inspectors to associate membership. Dr. Headlee was appointed to confer with the Association on this matter.

A motion by Dr. Headlee was carried by vote that this Section go on record in favor of apiary inspection work being placed under central authority and under the direction of one having had a broad entomological training.

It was moved and carried by vote that the Section adopt the suggestion of the Chairman that inspectors report disease conditions of apiaries along state boundaries to Dr. E. F. Phillips at Washington.

Upon motion by Mr. Millen a committee was appointed to draw up a uniform system of reporting apiary inspections. Mr. Shaw, Professor Dean and Mr. Millen were appointed on this committee.

By vote of the Section, Dr. T. J. Headlee was recommended to the Association of Economic Entomologists for Chairman of the Section and Mr. N. E. Shaw was reëlected Secretary.

THE FUNCTION OF THE APIARY INSPECTION SECTION

By E. F. Phillips

It is obvious that the formation of a section in the Association of Economic Entomologists for consideration of the problems in apiary inspection was a long step toward the proper recognition of the place of beekeeping in economic entomology. If we look back only a few years we will realize how impracticable it would then have been to get together a group of the economic entomologists of the United States who had any interest in beekeeping.

For a society to undertake improvement in the apiary inspection service is a large problem, in spite of the fact that we all realize the need of improvement in many places. We can scarcely hope to correct such defects as may exist without in some way reaching the men at work in the field and I would therefore respectfully commend for your deliberation the best means of reaching these men. It is impossible to get all the inspectors and deputies together once a year for a conference because of the great distances to be traveled and the lack of funds to pay their expenses as an official trip. Furthermore, most of the men engaged in the work are not members of the Association of Economic Entomologists and many, not being trained entomologists, are not eligible to membership under the present requirements. It is a pertinent question whether the Association should assume to have a section for such a special phase of economic entomology without making a special requirement to fit that section. Theoretically, it may be admitted that the standards for admission should be kept high, practically, it is a pity for an organization to limit its usefulness by keeping out men who need the help that they might well get from the organization. There is also room for debate on the question whether an organization is strengthened by artificial barriers of admission or whether its entire strength does not lie in its usefulness. The associate list might profitably be increased, in so far as this section is concerned, to include all apiary inspectors who care to join.

It is not easy to say what is the greatest need in apiary inspection but, after having traveled with a number of the inspectors, I should incline to the view that a reduction in the waste of time and more system in the work are most needed. To spend too much time in helping the individual beekeeper and to visit longer than necessary is a too common fault. In fact, some inspectors do little more than to make a series of visits to the members of the beekeepers' association every year, thus giving time to men who scarcely need the inspector and depriving others of less opportunity. There is often much waste in flitting from place to place. There is little this section can do to put a stop to these unwise things except to give public utterance to a condemnation of the practice.

As is well known, the Bureau of Entomology has for several years advised placing the apiary inspection under some already existing office, usually with the State Entomologist. It can be stated without fear of successful contradiction that in states where there is a competent experienced supervisor, the results are vastly better than in states where the inspector is a free lance. One important consideration is the keeping of adequate inspection records and these will not be properly kept unless there is an established central office. Case

after case could be mentioned of earnest effort which has come to no permanent good because of lack of supervision. I commend to this section the desirability of definite public utterance on this question for the guidance of the appointing powers and state legislatures.

At a conference of apiary inspectors held at the invitation of Mr. Frank C. Pellett, Apiary Inspector for Iowa, in Keokuk, Iowa, on September 8, 1915, Mr. N. E. France of Wisconsin called attention to a lack of coöperation among inspectors of adjacent states and made certain suggestions for overcoming the deficiency. To bring this before the section I desire to present the question for consideration.

The brood diseases of bees do not respect state boundaries and it would be well for an inspector to know of cases of disease found in counties that adjoin his state. This could be done simply by correspondence between the inspectors but this probably will not be done in many cases unless some regular system is devised.

As the inspectors know, the Bureau of Entomology notifies the inspector when a sample of diseased brood is received from the territory under his supervision. If it is the wish of the inspectors, the Bureau will gladly extend this by receiving reports of inspection along state lines and notifying the adjoining inspector. This will be rather easily done in conjunction with our maps on the distribution of the diseases.

Possibly this will not give as much information as the inspectors would like to have and it may be considered desirable to devise some other method of giving the information. In any event it would seem desirable that the prevalence of the disease be indicated and not merely a notice sent of the existence of the disease.

It would probably be desirable to have records of all cases of disease kept in some central office but this is beyond the needs of the case in point.

There is need of greater publicity of the work of the apiary inspectors, if for no other purpose to stimulate interest in the control of disease. Such publicity would do much to point out any waste of funds and I would suggest the desirability of gathering together every year the records of inspection in all the states where this work is done. To give the number of apiaries visited, the number that are being visited for the second time that season, the number that have been visited previous seasons, the amount of disease found, the money expended, as a total and per colony, and all available data as to any reduction in the prevalence of disease would do much to point out deficiencies and to stimulate to better work. It would, in fact, be the application to inspection of the methods of modern efficiency. Such a summary might be prepared by the Secretary of this section and published in

tabular form in the JOURNAL OF ECONOMIC ENTOMOLOGY. There would be cases of injustice in comparing cost of inspection per colony and each inspector should be permitted to add a brief statement of any reasons which might exist for unusual expense. Under this heading, a preponderance of small apiaries or difficulties of travel might be stated. An inspector who had a hard time in explaining why it costs twenty-five cents or more per colony might be stimulated to inspect more the following year. Some inspectors do considerable extension work and there should be a careful estimate of this expense to be deducted from the regular inspection expense with a statement of the number of days spent in each kind of work. This might bring out the fact that in some cases the inspection is being neglected and the time spent on certain lines of extension work which the conditions do not justify.

It is perhaps impossible to make a definite statement as to what constitutes inspection of a colony or apiary. If an inspector goes into a region where little or no disease exists and visits an apiary of 100 colonies belonging to a good beekeeper, he may not open a single colony or he may examine a few weak ones. He may be justified in reporting no disease in the apiary but if he reports having inspected 100 colonies, his record for the year is not comparable with that of another inspector who must examine every colony. It might be well to make a record of the total number of colonies and of the number actually examined. In some cases this would perhaps give an entirely different complexion to the report. Such a distinction is entirely warranted as giving a basis for judging whether the inspector is doing all he should. Of course it is assumed that all the reports of inspection of individual apiaries are truthful, which assumption may stand until there is evidence to the contrary.

In presenting these points for your consideration it may be well to summarize briefly the points mentioned.

1. Extension of the influence of this section.
2. Reduction in the waste of time in inspection.
3. Declaration of the need of a central office for the state inspection service.
4. The need of information concerning disease in adjacent states.
5. Summary of records of various state inspection service for comparison as to cost per colony and general efficiency.
6. Definition as to what constitutes inspection.

These suggestions are made because, with the impossibility of central control, there will certainly be a waste of funds in places unless it can be remedied by publicity. In certain cases of waste that have come to my attention it is clear that the inspector is acting in ac-

cordance with his best judgment and in an earnest effort to help beekeepers. If this section can provide a safer basis for judgment it will be conferring a great benefit on beekeepers who are suffering from neglect.

SOME DIFFICULTIES IN GROSS DIAGNOSIS OF THE INFECTIOUS BROOD DISEASES OF BEES

By ARTHUR H. MCCRAY, M. D., *Apicultural Assistant, Bureau of Entomology, U. S. Department of Agriculture.*

The beginner in diagnosis rarely appreciates the difficulties in recognizing and differentiating disease, consequently many mistakes are made and there results a lack of confidence in his own ability. Certainly this is deplorable. In this paper it is aimed to point out certain difficulties in the gross diagnosis of the infectious brood diseases of bees in such manner that the inexperienced inspector may profit thereby and it is hoped that those of greater experience may find something of value in the recital of some of the difficulties which have been encountered in the examination of over 4,500 different specimens of bee comb and brood representing every section of the United States.

DEAD, NOT LIVING, LARVÆ MUST BE STUDIED

The few published characteristics of living diseased larvæ are not readily applicable to gross diagnosis, especially in the field, consequently attention must be directed for the present almost exclusively to dead larvæ.

VARIATIONS IN THE SAME DISEASE

The various factors entering into a description of the dead brood in any one of the three known infectious brood diseases of bees are not constant, thus resulting in different appearances in different cases of the same disease. It is this variation that makes a differential gross diagnosis at times difficult or even impossible so that laboratory aid must be sought.

CONSIDERATION OF THE VARIATIONS AT LENGTH

It will be well to consider some of the more striking variations at greater length. Many lay great stress upon the value of odor in American foulbrood and European foulbrood. There is no doubt that most of the cases of American foulbrood, probably all, have at some time in the course of the disease a characteristic odor. The same cannot be said of European foulbrood for the odor here seems accidental and is not always present, more-

over, a very similar odor may be present in other conditions, probably in brood which has died from almost any cause, barring American foulbrood and sacbrood. The odor in American foulbrood may be very feeble, or absent altogether, and probably sometimes disappears on exposure to the air outside of the hive. Infected brood in the comb will undoubtedly absorb other odors if given the opportunity, thus the original characteristic odor of American foulbrood may be masked. This has been observed where specimens of comb and diseased brood from various sources have been thrown together in the waste basket and carted to the basement and allowed to lie there for some time preparatory to being destroyed. No odor has been detected in sacbrood. Odor is of value, therefore, only in American foulbrood. Color is usually regarded as of considerable value in differentiating between American foulbrood and European foulbrood. This is true in many cases but coloration is not by any means constant for either disease. Thus the coloration in some cases of American foulbrood, where young larvæ are affected, may closely resemble the usual coloration of most cases of European foulbrood. This usually leads to the mistake of diagnosing American foulbrood as European foulbrood or to that of diagnosing the presence of both diseases in the same comb. The consistency of the broken down larval mass is one of the most constant factors, yet this may not be sufficiently pronounced, as for instance the ropiness in American foulbrood, to differentiate as between it and European foulbrood. Especially confusing are those cases where in addition to the lack of ropiness there is present, as just mentioned in some cases of American foulbrood, coloration closely resembling European foulbrood. The age of the infected larvæ is usually an important aid in diagnosing between American foulbrood and European foulbrood. Every beekeeper, who knows anything about disease at all, has learned that in American foulbrood it is the older larvæ as a rule, or even pupæ, that present the manifestations of disease, while in European foulbrood diseased larvæ, much younger than in most cases of American foulbrood, are found. If not infrequently happens that the germs of American foulbrood give evidence of their presence in the larvæ at about the age at which European foulbrood usually manifests itself and, to increase the difficulties of differentiating, again the coloration of the larvæ and the general appearance may very closely simulate European foulbrood. To illustrate some of the variations just enumerated, I wish to describe for you the following specimen of diseased brood: Specimen No. 4725 from the apiary of John Kessler, Watertown, Jefferson County, Wisconsin, sent by Mr. L. V. France and examined by the writer July 1, 1915. The sample, it was stated, was obtained June 29, 1915, hence was examined pre-

sumably within 48 hours after removal from the hive. Mr. France wrote: "I have diagnosed the condition as American and European foulbrood both in the same comb." There were two pieces of comb each from a different colony. On opening these specimens of brood and before a miscroscopic or bacteriological examination, a tentative gross diagnosis of European foulbrood was made. On examining microscopically no evidence of either *Bacillus pluton* or *Bacillus alvei* could be found but spores of apparently *Bacillus larvæ* were present in abundance. On making bacteriological cultures the diagnosis of American foulbrood was confirmed instead of the tentative gross diagnosis of European foulbrood. No one could be blamed for making the mistake of diagnosing in the gross these two samples as European foulbrood. The affected larvæ in great number were young—about the age at which European foulbrood is seen in most of the samples received for diagnosis. Moreover, the larvæ presented the same yellow, grey and brown shades usually seen in European foulbrood and exhibited furthermore that peculiar appearance which the writer has described as melted, the larvæ presenting a moist collapsed mass as though gradually melting away under the influence of heat. In fact, there was practically nothing in the specimen to indicate by sight any other condition than the familiar appearance of many of the cases of European foulbrood. However, on thrusting the forceps, used in examining suspected brood, into the dead larvæ, it was noted that the consistency of the larvæ was more like American foulbrood than European foulbrood. These larvæ, as small as they were, showed an inclination to rope out more than would be expected from larvæ affected with European foulbrood and the larval mass was viscid in contradistinction to the more friable condition of European foulbrood larvæ. On continuing the examination, older larvæ, still more distinctly viscid, were found. Moreover, the cappings of most of the affected larvæ in both pieces of comb were sunken and only a few perforated cappings were found. However, neither sunken nor perforated cappings can be considered of any great value, both apparently being accidental features. Perforated cappings, especially, are liable to be found wherever pupæ die in sealed cells from any cause. Thus it will be seen that this specimen of diseased bee brood does not fit in well with the described condition applicable to either American foulbrood or European foulbrood for most cases. It is likely that, if this specimen could have been seen after the larvæ had formed the scale, differentiation would have been easy. Unfortunately, the comb was destroyed and later observations could not be made.

Consideration of Scales

This brings us to a consideration of the scales of the infectious brood diseases, especially those of American foulbrood and European foul-

brood. The scales of these diseases, as you all know, are formed by the drying of the affected larvæ. The character of these scales is usually so different that there is little danger of confusing one with the other. The scales of American foulbrood are so characteristic that a positive diagnosis of the disease in this stage can almost invariably be made. Let it be distinctly understood that a number of scales, not a single scale, is sufficient to make such positive diagnosis. It is not uncommon to receive for diagnosis, specimens of comb with a single affected larva, often in the form of a scale. Certainly no one should presume to make a gross diagnosis from such meagre material. Yet the same has been done and if the diagnosis was later confirmed by finding other infected larvæ in the colony, the original diagnosis should be considered good luck rather than skill. A laboratory diagnosis even, from a single larva, is frequently considered unsatisfactory by the examiner. Specimens are often received for diagnosis containing less than half a dozen scattered scales, or even a single scale of rubber-like consistency, which in coloration, position of being stretched out from base to top along the lower cell wall, and even difficulty with which it separates, all indicate scales of American foulbrood and no doubt such scales have been diagnosed as belonging to this disease. Closer examination, however, will usually reveal such scales to be of a lighter shade of brown than the scales of American foulbrood and they are not found in such great number in a given area of comb as American foulbrood scales. The decided rubber-like quality exhibited on attempting to break or draw out these scales, should put one on guard.

Besides these large rubber-like scales of European foulbrood there is the much more common form described as being smaller than American foulbrood scales, greyish-brownish or yellowish in color and lying usually against the base of the cell. These small scales are not nearly so characteristic of European foulbrood as are the scales described for American foulbrood. Larvæ dying from other causes may bear quite a close resemblance to the small greyish, brownish or yellowish scales of European foulbrood. The rubber-like scales of European foulbrood occur infrequently and in small numbers, hence in a small piece of comb might be mistaken for scales of American foulbrood. European foulbrood cannot be diagnosed in the scale stage with the certainty that American foulbrood can. In fact, it is practically impossible to diagnose European foulbrood after it has passed to the scale stage.

Scales are sometimes found in specimens of sacbrood. These are often quite dark, even black in coloration, sometimes with tint of grey, especially the under surface in contact with the cell wall from which they separate quite readily. The peculiar distended condition and granular watery content of larvæ affected with sacbrood should make

this condition in this stage easily diagnosed. The scale stage offers greater difficulties in gross diagnosis.

Consequences of Mistakes in Diagnosis

While the difficulties of diagnosis are such that errors must be made, yet these should be reduced to a minimum. The undesirable consequences following the application of improper treatment, based on a mistake in diagnosis, are obvious. Almost all of the mistakes possible have been made: thus, sacbrood has been mistaken both for American foulbrood and European foulbrood, likewise European foulbrood for American foulbrood and vice versa and treatment ordered accordingly, including unnecessary destruction of the frames and the rendering of the combs into wax with the consequent additional labor. Such mistakes as the above have been reported and unnecessary losses to the beekeeper could have been avoided by exercising proper discretion. It is better in doubtful cases to send a specimen for laboratory diagnosis. Mistakes are not so dangerous if made in a badly diseased territory since the chances of error in such cases are greatly reduced. But it is certainly desirable to have the diagnosis of suspected brood in a new territory confirmed unless there is so much suspected brood as to leave little doubt of infection.

OUTLINE OF APIARY INSPECTION IN ONTARIO

By Morley Pettit, *Provincial Apiarist, Guelph, Ontario*

It might be well to mention by way of introduction that the province of Ontario has a total area of four hundred thousand square miles, being much larger than any state of the Union. Only about 10 per cent of this area is as yet occupied, although every part has good agricultural districts as well as great mineral resources. The agricultural output of 1914 is valued at seven hundred and fifty million dollars.

Bees have been successfully kept in almost all parts of the province, and there are at present upwards of ten thousand persons keeping about three hundred thousand colonies and producing average crops of from 30 to 50 pounds per colony. The Ontario Beekeepers' Association has been in operation for 35 years and now has twenty-six affiliated county associations and a total membership of about twelve hundred. The annual government grants to beekeeping total about $10,000.00, only a part of which can be used for apiary inspection.

On the first enactment of foulbrood legislation in Ontario in 1890, one inspector was appointed by the Ontario Beekeepers' Association to spend part of his time inspecting bees under the direction of the president. In 1906 the act was revised and the province divided into

districts with a local inspector in each under the direction of the Minister of Agriculture. The present provincial apiarist was appointed in 1909 and given charge of the inspection system.

The present organization consists of the following divisions:

1. Bee disease legislation; 2. Conference and training of inspectors; 3. Educational correspondence with beekeepers to sustain interest and coöperation; 4. The bulletin on "Bee Diseases"; 5. Apiary demonstrations; 6. Field work of inspectors; 7. The system of reporting and centralization of control; 8. Organization of the central office.

Under the legislation, the number of inspectors is not restricted. They are appointed on the recommendation of the Minister of Agriculture, who usually consults the Provincial Apiarist. They work under his direction and are required to destroy the worst cases of disease, only leaving instructions for the cure of milder cases. They are authorized to order the transferring of colonies out of box hives. A heavy penalty is placed on the beekeeper for disposing of diseased bees or appliances in any way, and persons whose bees have been treated or destroyed for disease are forbidden to dispose of any bees or appliances whatever without permission from the inspector, on penalty of fine or imprisonment. Every person who is aware of the existence of foulbrood is required to report the same to the Minister of Agriculture on penalty of a fine.

The Inspectors' Conference is held at the Ontario Agricultural College at the time of the Beekeeping Short Course in January. Methods of inspection are fully discussed by the inspectors and resolutions passed by them which, commit them to a uniform policy of inspection work for the ensuing season.

During the early part of May some undergraduate specialists in beekeeping are given a course of training as inspectors and demonstrators. Most of these men have made good despite the opposition of some older beekeepers. Incidentally it is a part of their training as graduate specialists. Several have returned home to keep bees and are now making the best of local inspectors.

Under the slogan "Every beekeeper his own inspector," the coöperation of beekeepers themselves is sought by correspondence. First a letter is sent to the complete list early in spring warning against the danger of spreading disease by allowing robbing, and advising all owners of bees in box hives to prepare for transferring them during the swarming season.

Early in May, a letter goes to the disease list asking the beekeeper to be his own inspector and enclosing a report form with agreement to treat by a stated time, and a report of treatment to be signed and returned later. Returns from this are filed with the disease list. The

Ontario Department of Agriculture Bulletin 213, "Bee Diseases in Ontario," is also sent to those who have not previously received it.

Apiary demonstrations are arranged and advertised by form letters and cards sent out from the central office. Thanks are due the secretaries of county beekeepers' associations and the district representatives of the Department of Agriculture for much assistance in these arrangements. As far as possible each inspector conducts demonstrations in his own district.

When the weather is fairly well settled about May 24, inspectors are instructed to start work and cover as much territory as possible before the grant is exhausted. Reports are sent in daily and accounts weekly. The bookeeper gives notice when the money is nearly all used, and all are ordered to cease operations, except in very special cases. The objection to a geographical division of the grant is twofold: viz., the importance of an early discovery of cases of disease and the inclination of local inspectors to postpone work until everything is well looked after at home. Neglected districts very soon complain and the responsibility is then placed where it belongs.

As the grant has never been sufficient to inspect all known cases of disease, work is done in districts where the interest is best and the disease worst. With American foulbrood, the district is worked over thoroughly, but with European foulbrood, the ground is seldom covered the second time as this disease soon eliminates careless beekeepers.

Treatment is based on a diagnosis of symptoms of the beekeeper quite as much as of his bees. To this end the inspector is given forms which combine the record of past inspection with the current year's report. The form is a 5″ x 8″ card with heading showing the beekeepers' name and address, and exact location of apiary; also his rating as a "good," "average" or "poor" beekeeper and other items as to style of hive, etc. The results of inspection are reported in vertical columns with appropriate headings, one horizontal line being used each year.

The complete list of beekeepers for the district is sent to the inspector in these forms, also some blanks for new names. He is not expected to visit apiaries where disease is not suspected; but without going to extra expense is requested to revise all forms as far as possible, returning them from day to day with reports of inspection. Thus the disease inspector is also taking a bee survey of his district.

When disease is found and not destroyed, a small white label is pasted on the hive, showing the date and nature of disease. A red label covers this at the time of treatment. The beekeeper is required to sign an agreement to treat before a specified date. This is forwarded with the report of inspection and requires the beekeeper's signed statement of treatment at the proper time. If the report of treatment

is delayed, a letter goes to the beekeeper which usually gets a response. As far as possible the inspector looks after these cases next season and burns diseased material in cases of neglect.

In the central office the vertical system of cards and folders is used exclusively for keeping records. These are filed by a geographical numbering system which is easily explained. Each Ontario beekeeper is assigned a number of seven figures—the first two for his county, the second two for his township and the last three for his place among the beekeepers of his township. His 5″ x 8″ record card gives in condensed form most of the information we have of him as a beekeeper. There is also a 3″ x 5″ card index of the card record, arranged alphabetically by a numbering system, technically called the "L. B. Automatic Index." The list of beekeepers is on stencils for an addressing machine arranged geographically by numbers. This makes it easy to advertise local meetings in any part of the province. It is also useful for supplying lists of beekeepers to county secretaries, district representatives and others.

Practically every labor-saving device that it would be profitable to use in an office of this kind has been secured. These include in addition to the addressing machine, a stamp affixer, envelope sealer, duplicating machine and dictating machine.

Without the means to inspect all apiaries in a few years, a definite statement of the disease situation cannot be given. There is no hope of eradicating disease for some time at least; but by education the morale of the beekeeper is much improved, and with the passing of the neglected farm apiary, the chief disease menace to amateur and commercial beekeeping is removed.

The following items, from the 1915 Annual Report on "Apiary Inspection in Ontario," may be of interest. Twenty-one inspectors were employed for what time they could spare from home during the month of June. In the European foulbrood districts visits were made to 391 apiaries, containing 5,367 colonies. One hundred and ninety-four of these apiaries were diseased, the number of diseased colonies being 1,387. In the American foulbrood districts, 611 apiaries were visited, consisting of 10,825 colonies. One hundred and seventy-nine apiaries were found diseased, the number of diseased colonies being 921. As previously stated, inspection in European foulbrood districts was only on the outskirts. In many cases the infection was slight and was under control. The inspector's work consists mainly in warning against the danger of black bees and weak colonies.

The inspectors of American foulbrood report about the same percentage of disease as last year. This is encouraging as the failure of the honey crop in 1914 and resultant robbing was expected to spread disease.

Proceedings of the Fourteenth Annual Meeting of the American Association of Official Horticultural Inspectors

The fourteenth annual meeting of the American Association of Official Horticultural Inspectors was held in Columbus, Ohio, December 28 and 29, 1915. On the evening of December 28 the first session was called to order in the House of Representatives, State Capitol, by the Chairman, W. E. Rumsey, with J. G. Sanders, Secretary.

The second session was held in the Botany and Zoölogy Building of the Ohio State University at 10.00 a. m. Wednesday, December 29.

The Legislative Committee of the National Nurserymen's Association was represented on invitation by Mr. J. H. Dayton of the Storrs & Harrison Co., Painesville, Ohio, who reported on the acceptance of the Uniform Inspection Bill by the nurserymen at their national convention in Detroit, Michigan, in June, 1915. Mr. Dayton reported that it was a gratifying advance in horticultural legislation to note the closer feeling of coöperation among the nurserymen and the entomologists. He conveyed the sentiments of the nurserymen to our Association and expressed a wish for the continued good feeling and coöperation existing at present.

The program as presented at the two sessions of the meetings was as follows:

PROGRAM

Tuesday, December 28, 1915, 8.00 p. m.

1. Address of the Chairman: "Control of the Cedar Rust in West Virginia," by Professor W. E. Rumsey, Morgantown, W. Va.
2. "Foreign Pests Recently Established in New Jersey," by Harry B. Weiss, New Brunswick, N. J. (10 minutes.)
3. "Imported Insect Pests Collected on Imported Nursery Stock in 1915," by E. R. Sasscer, Washington, D. C. (10 minutes.)
4. "The Uniform Horticultural Inspection Law," by J. G. Sanders, Madison, Wis. (10 minutes.)
5. "Report of the Legislative Committee of the National Nurserymen's Association," by J. H. Dayton, Painesville, Ohio.

Wednesday, December 29, 1915, 10.00 a. m.

6. "Remarks on Inspection Facilities in the District of Columbia," by E. R. Sasscer, Washington, D. C. Illustrated. (10 minutes.)
7. "Vacuum Fumigation and Its Application to the Control of Insects Affecting Plants and Plant Products," by E. R. Sasscer, Washington, D. C. Illustrated. (15 minutes.)
8. "The Betterment of Pathological Inspection," by R. Kent Beattie, Washington, D. C.
9. "Nursery Inspection in Florida," by F. M. O'Byrne, Gainesville, Fla.

10. "Coöperation in the Establishment of State Quarantines," by J. Edward Taylor, Salt Lake City, Utah.

11. "The Ohio Inspection System," by N. E. Shaw, Columbus, Ohio. Illustrated. (15 minutes.)

Business

Professor W. J. Schoene, Blacksburg, Virginia, was nominated as Chairman of this section for 1916, and J. G. Sanders, Madison, Wisconsin, was reëlected Secretary.

The following persons were in attendance at the sessions of the meetings:

Ed. L. Ayers, Austin, Tex.
R. Kent Beattie, Washington, D. C.
Geo. G. Becker, Fayetteville, Ark.
G. M. Bentley, Knoxville, Tenn.
E. C. Cotton, Elyria, O.
J. H. Dayton, Painesville, O.
Geo. A. Dean, Manhattan, Kan.
D. M. DeLong, Columbus, O.
Harry F. Dietz, Indianapolis, Ind.
H. E. Evans, Columbus, O.
W. E. Evans, Jr., Painesville, O.
Richard Faxon, Elyria, O.
E. P. Felt, Albany, N. Y.
F. A. Fenton, W. Lafayette, Ind.
S. B. Fracker, Madison, Wis.
F. D. Heckathorn, Painesville, O.
E. J. Hoddy, Columbus, O.
Neale F. Howard, Columbus, O.
S. J. Hunter, Lawrence, Kan.
B. F. Kindig, Elkhart, Ind.
Max. Kislink, Jr., Washington, D. C.
R. W. Leiby, Raleigh, N. C.
P. W. Mason, LaFayette, Ind.
R. S. McKay, Owensville, O.
E. M. Mendenhall, Columbus, O.
G. B. Merrill, N. Abington, Mass.
Joseph H. Merrill, Manhattan, Kan.
Harold Morrison, Indianapolis, Ind.
H. Ness, Ames, Iowa.
Owen Nelson, Laramie, Wyo.
F. M. O'Byrne, Gainesville, Fla.
L. M. Peairs, Morgantown, W. Va.
Morley Pettit, Guelph, Ont.
W. A. Price, LaFayette, Ind.
Jesse M. Robinson, Columbus, O.
Lowell Roudebush, New Richmond, O.
W. E. Rumsey, Morgantown, W. Va.
J. G. Sanders, Madison, Wis.
E. R. Sasscer, Washington, D. C.
A. F. Satterthwait, W. LaFayette, Ind.
W. J. Schoene, Blacksburg, Va.
Geo. D. Shafer, East Lansing, Mich.
N. E. Shaw, Columbus, O.
Mrs. L. C. R. Smythe, Topeka, Kan.
Perley Spaulding, Washington, D. C.
H. J. Speaker, Sandusky, O.
J. Edward Taylor, Salt Lake City, Utah.
F. L. Thomas, Auburn, Ala.
J. Troop, LaFayette, Ind.
Geo. H. Vansell, Lexington, Ky.
C. H. Waid, Wauseon, O.
Frank N. Wallace, Indianapolis, Ind.
R. L. Webster, Ames, Iowa.
Don B. Whelan, East Lansing, Mich.
P. B. Wiltberger, Columbus, O.
L. H. Worthley, Boston, Mass.

Summary of Papers and Discussions

1. Address of the Chairman. Professor Rumsey described the losses occasioned by the "cedar rust" on the apple crop in West Virginia and outlined the steps taken for controlling the situation, which included the destruction of cedars over a large area. Some conflict with property owners was encountered but after tactful maneuvering the situation was cared for and the difficulties overcome. The situation is gratifying at the present time. Dr. Headlee asked what diameter

of zone was considered necessary for immunity from the "cedar rust" disease. Mr. Rumsey replied that one mile from commercial orchards was decided as necessary distance and this plan was carried out wherever possible. Remarks were made by several relative to the compensation for destruction of property in cleanup work for diseases and pests.

2. Mr. Weiss' paper, which listed the many species of insects which have been recently introduced and have become established in New Jersey, was presented by Dr. Headlee who supplemented the paper with remarks in which he recommended rather drastic action to prevent repetition of these alarming conditions. During the discussion it was moved by Dr. Headlee "that it be the sense of this body that the federal quarantine be strengthened, and that an absolute quarantine be placed on all plants imported with soil about the roots, except such as are introduced by the U. S. Department of Agriculture for experiment and those to be held in quarantine for a reasonable period." This motion was passed unanimously and the Secretary instructed to notify the Federal Board of this action.

It was further suggested by one of the members, that state inspectors should convey their suggestions and judgment on inspection matters to the Federal Horticultural Board; and further, that state inspectors and officials take notice of hearings before this Board (which are usually advertised), and that whenever possible should be present at these meetings.

Mr. Burgess reported that Christmas trees and greens to the extent of over forty-one carloads, containing 1,200 to 1,800 trees each, had been shipped from the quarantine area in New England, all of which had been inspected previous to shipment and a considerable number of egg clusters of the gipsy moth had been found on these trees. All carload lots went from New Hampshire and Maine and had been shipped to many of the states of the Union, including such states as Michigan, Wisconsin, Minnesota, Washington and Oregon, where already grows a plentiful supply of Christmas trees and greens.

It was the sense of the inspectors present that the Federal Quarantine should be replaced on Christmas greens, otherwise several of the states would absolutely quarantine the shipments of Christmas trees originating in the moth quarantine area.

3. "Imported Insect Pests Collected on Imported Nursery Stock in 1915," by E. R. Sasscer, Washington, D. C.

In this paper, which will appear later in the JOURNAL, Mr. Sasscer reports special features of the inspection of imported nursery stock under the Federal Plant Quarantine Act. He called attention to the annually increasing amount of imported nursery stock, and reported

the detection of a number of dangerous insects. Special attention was called to the fact that recently two troublesome insects, namely, the European ear-wig and the European mole cricket, had become established in certain eastern states. It is the belief of the writer that these insects had been introduced in soil about the roots of imported plants.

4. The Secretary reported that the Uniform Horticultural Inspection law, which had been under consideration for three years, had been considered by a committee appointed at the last annual meeting and alterations and improvements were made in the bill.

This bill was finally adopted by the National Nurserymen's Association in their annual meeting in Detroit in June, 1915, and Mr. Curtiss Nye Smith of Boston had been retained as their attorney to aid in the adoption of this bill, wholly or in part, wherever changes in state horticultural inspection laws were contemplated.

5. The substance of Mr. Dayton's remarks appears on a previous page.

6. Mr. Sasscer explained the convenient arrangement of buildings and apparatus for inspection of material introduced into the District of Columbia, and described the extreme precautions for sanitation where suspected plant material was being examined and quarantined.

7. Mr. Sasscer's paper on vacuum fumigation is withheld for publication elsewhere, but the importance of the results which he has secured in fumigating tightly packed bales of cotton by the vacuum processes, using cyanide gas, marks a greatly advanced step in fumigation methods. We can scarcely realize what may be the ultimate outcome of this method of successful fumigation.

8. Mr. Beattie's plea for more carefully trained inspectors was gratifying. He illustrated by several examples what diseases have become established through inefficient and poorly trained inspectors where recognition of dangerous plant diseases was not possible until too late.

9. Nursery inspection conditions in Florida were outlined by Mr. O'Byrne, whose paper will be published later.

10. Mr. J. Edward Taylor described the conditions regarding state quarantines in the West, which were not desirable, and pleaded for greater coöperation among the states. He spoke particularly regarding the effect of unfortunate state quarantines on the shipment of alfalfa seed with regard to possible alfalfa weevil infestation.

11. Illustrated with a series of fine slides, Mr. Shaw described the Ohio system of nursery inspection and the methods used in inspection and fumigation of infested stock. A number of fumigation houses of different types were illustrated and valuable pointers in fumigation house construction were offered.

CONTROL OF THE CEDAR RUST IN WEST VIRGINIA

ADDRESS OF THE CHAIRMAN

By W. E. Rumsey, *Morgantown, W. Va.*

Gentlemen: To have the honor of presiding at a session of our Association is certainly appreciated by your present chairman. An elaborate address will not be attempted but some remarks may be appropriate at this time concerning the "snags" encountered by West Virginia in attempting to enforce certain features of her nursery and orchard inspection laws. Therefore, with your indulgence, the eradication of red cedars in the vicinity of apple orchards will be considered.

The damage by apple rust or so-called "cedar rust" to orchards in the eastern panhandle of our state has been enormous, amounting to $75,000.00 in 1912 in Berkeley county alone. This is a conservative estimate and includes merely the loss to the crop for that year, not taking into consideration the devitalization of the trees which prevented them from developing fruit-buds for a succeeding crop.

Since the scope of our crop pest law includes any dangerously injurious insects or plant diseases that are liable to spread and cause damage, the commission decided to make an effort to check apple rust by the removal of red cedars in sections where the apple industry had developed sufficiently to make the cedar trees a nuisance. Spraying for this disease is not practical commercially as has been determined by investigations of our plant pathologist, N. J. Giddings, and others, hence the only recourse is the removal of cedars.

The cedar tree proposition is rather unique. These trees have been growing in certain portions of our state since time immemorial, and it has been only within the last few years that the disease, which cedars harbor, has caused any serious loss to apple crops. At the present time these trees do the general farmer no particular harm except to take his pasture fields, for the cedars come up from seeds like weeds and it is said that no kind of stock will eat even the young plants. Besides this there is an æsthetic side that must not be ignored. Long stretches of cedars on both sides of country roads and clumps of them, clothed in perpetual green, covering many rocky knolls and ledges of the limestone outcrop, add much to the scenic beauty of the Shenandoah Valley.

Owing to the prevalence and destructiveness of apple rust in Berkeley county, one of the foremost apple sections of our state, the commission began its activities in this territory. On account of the unique-

ness of this work, as already pointed out, it was deemed advisable to start off with a campaign of education. Therefore, the state entomologist was sent into the territory to visit the general farmers and convince them, first: that cedar trees were responsible for the great loss from apple rust to the orchard industry of their community, and, second: that for the benefit of their county they should coöperate with the orchardists in the fight against this disease. Other duties of the entomologist compelled him to leave the field and a local inspector was appointed to continue the work. It soon became evident that the fruit-growers did not like the policy adopted by the commission for they began "nagging" at our inspector to resort to the law and cut the cedars under its provision. This attitude of the orchardists at once counteracted any impression we may have made toward obtaining coöperation and there arose two fighting factions: the general farmers uniting to prevent the work of the state, declaring the law to be unconstitutional, and the orchardists clamoring for a test case to be brought before the court. Under these circumstances the commission could not back down, so in February, 1914, cedar cutting began on the property of an extensive land owner who immediately had the inspector and his helpers arrested and got out an injunction to restrain the commission and any of its employees from entering upon his premises. It was now evident that to get the cedars removed other tactics must be used. Therefore the entomologist returned to the front and visited the trenches of the opposing forces as a sort of peacemaker. He obtained permission from the general farmers to allow the removal of their cedars provided the work would be done strictly in accordance with their wishes under the supervision of a state man and without cost, the orchardist furnishing the labor. The fact was pointed out to the fruit-growers that if the commission persisted in its efforts to enforce the law many other farmers would undoubtedly get out injunctions which would prevent cedars being cut on such premises until after the litigations were adjusted. However, it was stated that permission had been obtained from the general farmers to cut their cedars provided it was of no expense to them. Therefore, labor must be furnished by the orchardists to remove these trees if they wished to save the apple crop. The fruit-growers readily fell into line and thus the tactics adopted proved successful. Immediately a different atmosphere seemed to pervade the community and cedar trees fell by the tens of thousands with a result that apple rust was checked to a marked degree.

Although the court has decided that our inspection law is constitutional we are still removing cedars under the plan just described, for by so doing, not only peace and good will prevail between the general

farmers and fruit-growers, but all the cedar trees on a tract are cut at once. If we were removing the cedars in strict accordance with the law, only those harboring cedar apples or balls could be cut, hence making it necessary to go over the ground year after year to destroy other cedars that have become infected since the previous inspection.

A MODEL STATE HORTICULTURAL INSPECTION LAW[1]

By J. G. SANDERS, *Madison, Wis.*

Greater uniformity in legislation of the various states regulating the inspection and transportation of nursery stock and horticultural inspection generally, was discussed in this JOURNAL[2] in 1914.

At the Atlanta meeting of our Association the writer offered for consideration a preliminary draft of a horticultural inspection bill, which would, through its text or by the promulgation of rules and regulations, cover practically all phases of inspection and emergencies which would arise under the inspection work.

The bill was discussed by the inspectors present and also by members of the Legislative Committee of the National Nurserymen's Association, who were invited to attend our meeting. The writer, working in coöperation with members of the Inspectors' Association and the Legislative Committee of Nurserymen, revised and redrafted a bill which was again presented at the Philadelphia meeting. Here various suggestions for improvement were offered and a committee of five was appointed to confer as to the final wording of the bill and having power to act. Various conferences were held with Mr. William Pitkin, Chairman of the Nurserymen's Legislative Committee, and suggested changes for improvement were made in the bill.

In June, 1915, at the Detroit meeting of the National Nurserymen's Association, the bill, as drafted and as is published herewith, was finally adopted.

The great interest manifested in uniform legislation by the nurserymen, and particularly their willingness to adopt a bill so drastic in its power as the present one, is most praiseworthy. A marked change in feeling between the nurserymen and the entomologists and inspectors has taken place, each of the contending parties realizing more keenly the problems of the other. The nurserymen, we feel sure, are coming to realize the importance of more careful and thorough inspection, and to realize the necessity for coöperation and assistance in this work.

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[1] Prepared and adopted by the American Association of Official Horticultural Inspectors and the American Association of Nurserymen.

[2] JOUR. ECON. ENT., vii, p. 102, 1914.

The nurserymen have expressed themselves strongly in favor of more thorough training of inspectors and more careful work to insure clean stock and fewer mistakes in the condemnation of stock without warrant.

The entomologists and inspectors fully appreciate the present situation which is handicapped to a greater or less degree in some states by lack of funds for the employment of better trained and more experienced men.

State laws, which are as nearly uniform as local conditions will permit, will aid wonderfully in the inspection, fumigation, packing and transportation of nursery stock. Hence, we believe that the adoption of this bill, which has been worked over with great care by entomologists and nurserymen with the aid of legal advice, will materially assist in undesirable conditions which now exist where each state has its own provisions differing widely from those of its neighbor. The Uniform Bill as offered should be adopted as nearly as possible in its presented form, when changes are contemplated in state laws. The Nurserymen's Association has offered their assistance through their national body, as well as their state organizations, to further this project, and those interested should feel free to call on them for help.

The bill as offered is not presumed to be perfect, but is thought to cover all possible exigencies which may arise either through the text offered or by the power for promulgation of rules and regulations as provided in section 6.

The writer, as Secretary of the Inspectors' Association, will be glad to aid in the adoption of horticultural laws whenever his assistance is desired.

A MODEL STATE HORTICULTURAL INSPECTION LAW

NOTE—The parenthetical words and phrases are to be understood as options suitable to local state conditions and usage.

[Bill No.——, Approved —— 19——. Chap. or Sec.——, Laws of———]. Be it enacted by the (Legislature) (people) of the state of —— (represented in) (General Assembly) (Senate and Assembly) that,—

Section 1.—The following terms as used in (this act) (sections —— to ——, inclusive) shall be construed as follows:—

1.—The singular and plural forms of any word or term in (this act) (section —— to ——, inclusive) shall be construed as interchangeable and equivalent within the meaning of the act.

2.—The term "person" shall include corporations, companies, societies, associations, partnerships or any individual or combination of individuals. When construing and enforcing the provisions of (this act) (sections —— to ——, inclusive) the act, omission, or failure of any officer, agent, servant or other individual acting

for or employed by any person as above defined within the scope of his employment or office, shall in every case be also deemed to be the act, omission or failure of such person as well as that of the individual himself.

3.—The terms "insects" and "plant diseases" appearing in (this act) (sections —— to ——, inclusive) shall be construed to include any stage or stages of development of the aforesaid insects or plant diseases.

4.—The term "nursery stock" shall include all field-grown florist stock, trees, shrubs, vines, cuttings, grafts, scions, buds, fruit-pits and other seeds of fruit and ornamental trees and shrubs, and other plants and plant products for propagation, except field, vegetable, and flower seeds, bedding plants, and other herbaceous plants, bulbs and roots.

5.—The term "nursery" shall be construed to mean any grounds or premises on or in which nursery stock is propagated and grown for sale, or any grounds or premises on or in which nursery stock is being fumigated, treated, packed or stored.

6.—The term "nurseryman" shall mean the person who owns, leases, manages or is in charge of a nursery.

7.—The term "dealer" shall be construed to apply to any person not a grower of nursery stock who buys nursery stock for the purpose of reselling and reshipping, independently of any control of a nursery.

8.—The term "agent" shall be construed as applying to any person selling nursery stock under the partial or full control of a nurseryman, or of a dealer or other agent. This term shall also apply to any person engaged with a nurseryman, dealer or agent in handling nursery stock on a coöperative basis.

Section 2.—There is hereby created a board which shall be known as the "Horticultural Inspection Board" of (State), hereinafter called the Board, consisting of three (five) members, two (four) members of which shall be ex-officio members. The third (fifth) member shall be appointed by the Governor for a term of four years. Such third (fifth) member shall be a nurseryman actively engaged in the growing of nursery stock. A majority of the members of the Board shall constitute a quorum. Vacancies occurring from death, resignation, removal or inability to act shall be filled in like manner for the unexpired term. The members of said board shall elect a chairman and shall serve without compensation, but shall receive their actual and necessary traveling expenses incurred in the discharge of their official duties within the provisions of (this act) (sections —— to ——, inclusive). This board is hereby vested with all powers necessary to carry out the provisions of (this act) (sections —— to ——, inclusive).

APPOINTMENT

Section 3.—The Board shall appoint some person qualified by scientific training and practical experience to be state nursery inspector, hereinafter called the inspector who shall hold his office during the pleasure of the Board, and shall strictly enforce the provisions of (this act) (sections —— to ——, inclusive) as a police regulation of the (state) (commonwealth) under the direction and control of the Board.

BOND

Section 4.—The inspector shall file with the Board a bond with security to be approved by the Board in the sum of one thousand dollars, conditioned on faithful performance of his duty. Any person suffering loss occasioned by reason of an act or omission of the inspector and deputies which is deemed to be unjustifiable, may maintain an action upon said bond against the inspector and sureties thereon

for such loss not to exceed the amount of said bond. Indemnity bonds with sufficient sureties running to the inspector and the sureties upon his bond may be required of deputy inspectors.

Appointment of Deputies

Section 5.—The Board is hereby authorised to appoint or dismiss on the recommendation of the inspector (deputies) (county horticultural inspectors) (district horticultural inspectors) who shall strictly enforce the provisions of (this act) (sections —— to ——, inclusive) under the direction of the Board, and they are hereby endowed with the same police power as the inspector, and shall be furnished with official badges or other insignia of authority, which shall be carried while on duty.

Section 6.—The Board shall have the power to prescribe, modify and enforce such reasonable rules, regulations and orders as may be needed to carry out the provisions of this act, and may publish an annual report describing the various phases of the inspection work, or may publish such other information as may seem desirable concerning the inspection and such insects and diseases as are covered by (this act) (sections —— to ——, inclusive). Such rules and regulations shall be printed from time to time and furnished free to interested parties.

Inspector's Duties and Powers

Section 7.—The Board through the inspector or deputies shall at least once each year inspect all nurseries and other places in which nursery stock is kept for sale. For this purpose such inspector or deputies shall have free access, within reasonable hours, to any field, orchard, garden, packing ground, building, cellar, freight or express office, warehouse, car, vessel, or other place, which it may be necessary or desirable for him to enter in carrying out the provisions of this act. It shall be unlawful to deny such access to the inspector or deputies or to hinder, thwart or defeat such inspection by misrepresentation or concealment of facts or conditions or otherwise.

Section 8.—The Board through the inspector or deputies shall have the authority to inspect any orchard, fruit or garden plantation, park, cemetery, private premises, public place, and any place which might become infested or infected with dangerous or harmful insects or plant diseases. It shall also have the authority to inspect or reinspect at any time or place any nursery stock shipped in or into the state and to treat it as hereinafter provided.

Diseased Plant Material on Premises

Section 9.—The Board is hereby empowered to prohibit and prevent the removal or shipment or transportation of plant material and any other material from any private or public property, or property owned or controlled by the state, or any area of the state (commonwealth) which in its judgment contains dangerously infested or infected nursery stock or plant or other material of any kind for such periods and under such conditions as in its judgment seems necessary in order to prevent the further spread of the infestation or infection, giving such notice thereof as may be prescribed by the Board; and during the existence of such order no person shall remove or ship from such area any such material whatsoever, except by special permission or direction of the Board.

Section 10.—It shall be unlawful for any person in this state knowingly to permit any dangerous insect or plant disease to exist in or on his premises. It shall also

be unlawful to sell or to offer for sale any stock infested or infected with such insect or disease.

Section 11.—In case the inspector or deputy shall find present on any nursery or dealer's premises or any packing ground or in any cellar or building used for storage or sale of nursery stock, any injurious insect or plant disease, he shall notify the owner or person having charge of the premises, in writing, to that effect, and the Board shall withhold his certificate hereinafter provided for, until the premises are freed from such injurious insect or plant disease, as hereinafter provided. It shall be unlawful for any person after receiving such notice to ship or deliver or cause to be shipped or delivered any nursery stock from such aforesaid premises.

Section 12.—(1) If the inspector or deputy shall find on examination any nursery, orchard, small fruit plantation, park, cemetery, or any private or public premises infested with injurious insects or plant diseases, he shall notify the owner or person having charge of such premises to that effect, and the owner or person having charge of the premises shall within ten days after such notice cause the removal and destruction of such trees, plants, shrubs or other plant material if incapable of successful treatment; otherwise, cause them to be treated as the Board may direct. No damages shall be awarded to the owner for the loss of infested or infected trees, plants, shrubs or other plant material under this act.

(2) In case the owner or person in charge of such premises shall refuse or neglect to carry out the orders of the Board within ten days after receiving written notice, the Board may proceed to treat or destroy the infested or infected plants or plant material. The expense thereof shall be assessed, collected and enforced as taxes are assessed, collected and enforced against the premises upon which such expense was incurred. The amount of such expense when collected shall be paid to and become a part of the fund used to enforce the provisions of (this act) (sections —— to ——, inclusive).

Application for Inspection

Section 13.—Persons desiring to sell or ship nursery stock shall make application in writing before July 1st of each year to the Board for inspection of their stock. Persons failing to comply with this section shall be liable for extra charges to cover traveling expenses of the inspector.

Imported Stock

Section 14.—Every person receiving directly or indirectly any nursery stock from foreign countries shall notify the Board of the arrival of such shipment, the contents thereof and the name of the consignor; and shall hold such shipment unopened until duly inspected or released by the Board. In case any infested or infected stock is discovered in such shipment, the shipment shall be subject to the provisions of (this act) (sections —— to ——, inclusive).

Nursery Certificate

Section 15.—(1) The Board shall cause to be issued to owners of any nursery in the state after the stock has been officially inspected as previously provided, and found to be apparently free from injurious insects or plant diseases, a certificate signed by the inspector setting forth the fact of such inspection and the number of acres or fraction thereof inspected. Said certificate shall be valid not to exceed one year from (month) 1st.

(2) It shall be unlawful for any person to sell, to offer for sale or to remove or ship from a nursery or other premises, any nursery stock unless such stock has been officially inspected and a certificate or permit has been granted by the Board.

Dealer's Certificate

Section 16.—All dealers within the meaning of this act, located either within or without the state, engaged in selling nursery stock in this state or soliciting orders for nursery stock within this state, shall secure a dealer's certificate by furnishing a sworn affidavit that he will buy and sell only stock which has been duly inspected and certified by an official state inspector; and that he will maintain with the Board a list of all sources from which he secures his stock.

Certificates to Firms Outside the State

Section 17.—Nurserymen, dealers or other persons residing or doing business outside the state desiring to solicit orders for nursery stock in the state shall, upon filing a certified copy of their original state certificate with the Board obtain a certificate permitting such persons to solicit orders for nursery stock in this state.

Agent's Certificate

Section 18.—All agents within the meaning of this act selling nursery stock or soliciting orders for nursery stock for any nurseryman or dealer located within the state or outside the state, shall be required to secure and carry an agent's certificate bearing a copy of the certificate held by the principal. Said agent's certificate shall be issued only by the Board to agents authorised by their principal or upon request of their principal. Names and addresses of such agents shall not be divulged by the inspector or the Board.

Section 19.—The Board shall at any time have the power to revoke any certificate for sufficient cause, including any violation of (this act) (sections —— to ——, inclusive) or non-conformity with any rule or regulation promulgated under (this act) (sections —— to ——, inclusive).

Misrepresentation of Stock

Section 20.—(1) It shall be unlawful for any person to wilfully misrepresent to any other person the grade, character, variety, or quality of stock in a nursery, or of stock offered for sale by any nurseryman, dealer, or agent, or to make a false declaration of acreage or to cause any concealment of stock from inspection.

(2) Every person selling nursery stock in the state shall, if requested, furnish the Board with copies of his order forms, contracts and agreements with his customers, which are furnished for the use of agents or customers or both.

Certificate Shipping Tags

Section 21.—Every person who shall engage in the selling and shipping of nursery stock in the state is hereby required to attach on the outside of each package, box, bale, or carload lot so shipped or otherwise delivered, a tag or poster on which shall appear an exact copy of his valid certificate. The use of tags or posters bearing an invalid or altered certificate and the misuse of any valid certificate tag is hereby prohibited.

Section 22.—It shall be unlawful for any person to accept for shipment any nursery stock without a valid certificate plainly affixed on the outside of the package, bale, box or car containing the same, showing that the contents have been duly inspected

by an official state or federal inspector. In case any nursery stock is shipped in this state, or into this state from another state, country or province, without the aforesaid valid certificate plainly affixed, the fact must be promptly reported to the Board by the person carrying the same, stating the consignor and the consignee and the nature of the shipment.

APPEAL

Section 23.—(1) Any person in interest or affected by any order of the Board or inspector may appeal therefrom to the Board within five days of the service of such order upon him setting forth in writing specifically and in full detail the order on which a hearing is desired, and every reason why such order is deemed to be unreasonable.

(2) On receipt of such appeal the Board shall with reasonable promptness order a hearing thereon and consider and determine the matters in question. Notice of the time and place of hearing shall be given to the petitioner and to such other persons as the Board may direct. Such appeal shall not suspend the operation of the order appealed from unless so ordered by said Board. All hearings of the Board shall be open to the public.

Section 24.—Compensation of inspector or deputy inspectors (a local matter).

PENALTY FOR VIOLATIONS

Section 25.—Any person violating (any section of this act) (any one or more of sections —— to ——, inclusive) or any rule or regulation promulgated under this act, shall be guilty of a misdemeanor and on conviction thereof shall be fined the sum of not less than $25.00 nor more than $500.00 for each offense.

Section 26.—It shall be the duty of each (District Attorney) (County Attorney) to whom the Board shall present satisfactory evidence of violation of any provision of (this act) (sections —— to ——, inclusive) to prosecute without delay such violations in the proper court.

Section 27.—Appropriations, fees, gifts or other support of the horticultural inspection service (a local matter).

Section 28.—(This act) (sections —— to ——, inclusive) shall take effect and be in force from and after [passage and approval (and publication)] (date).

FOREIGN PESTS RECENTLY ESTABLISHED IN NEW JERSEY

By HARRY B. WEISS, *New Brunswick, N. J.*

During the past couple of years, the following insects were found to be established in varying numbers in different parts of New Jersey. Practically all were introduced on imported nursery stock and their presence is an indication of the impossibility of hoping to keep out all foreign pests by a system of inspection. Insect importations and subsequent establishments will undoubtedly continue just as long as nursery stock is imported inasmuch as the protection afforded by inspection is necessarily only partial and sometimes ineffective depend-

ing as it does on the experience, ability and carefulness of the inspector and the impossibility of closely examining every individual plant.

Lepidoptera

Gracilaria zachrysa Meyrick has been found in greenhouses in northern New Jersey, the larvæ of which turn over the tips and edges of azalea leaves and feed therein, causing them to turn black and die. This species has also been taken in the larval and pupal stages on azaleas imported from Belgium and was evidently introduced from that country. *Evetria buoliana* Shiff., which is the well-known, destructive European pine-shoot moth on whose account the further importation of pines from Europe has been prohibited, is also established in New Jersey.

Orthoptera

In this order we have *Gryllotalpa gryllotalpa* L., the European mole cricket to which numerous European writings refer as a troublesome pest. The party on whose premises it was discovered claims to have destroyed at least 20,000 including eggs. This insect undoubtedly came over in the soil around plants from Holland or Belgium or both of these countries and the impossibility of thoroughly inspecting soil in such conditions is self evident.

Coleoptera

In this group we have *Otiorhynchus sulcatus* Fab., long established in this country, suddenly becoming quite active as a rhododendron pest in several parts of the state. *Agrilus viridis* L. var. *fagi* Ratz., which does considerable damage to standard and *Rugosa* roses, is another foreign beetle which is prevalent in New Jersey. Still another and much more injurious beetle, especially to Scotch fir, is *Myelophilus piniperda* L., which as far as is known has only a slight foothold in the state. *Plagiodera versicolora* Laicharting, which is an old name for the common *P. armoricæ* of Europe, was found during the last two summers injuring poplars and willows at Arlington, Elizabeth and Irvington. Both the larval and adult stages feed on the foliage and do considerable damage. This species is firmly established in New Jersey.

Diptera

This order is represented by *Phytomyza aquifolii* Gour., lately found mining the leaves of English holly and also taken on holly imported from Europe (Holland), by *Merodon equestris* L., known as the narcissus fly, which was evidently introduced in bulbs from Holland where it does considerable damage, and by *Monarthropalpus*

buxi Lab., the box leaf miner, recently found injuring boxwood on private estates and taken at various times on boxwood from Holland.

HOMOPTERA

This group contains eight species, four of which were found established on outside stock and four on greenhouse plants. The four on outside stock came originally from Japan and are *Antonina crawi* Ckll., the cottony bamboo scale on bamboo, *Leucaspis bambusæ* Kuwana, another scale insect on bamboo, *Aspidiotus tsugæ* Marlatt on Japanese hemlock and *Pseudococcus kraunhiæ* Kuwana, a mealy bug on *Taxus cuspidata brevifolia*. Three of the greenhouse species are coccids which were found infesting orchids. These are *Targionia biformis* Ckll., from Brazil and Venezuela, *Chrysomphalus perseæ* Comst., from Guatemala, and *Chrysomphalus rossi* Mask., from the Philippine Islands. The other is a species of white fly (*Aleyrodes* sp.) which is continually being introduced into New Jersey greenhouses on azaleas from Belgium.

It must be understood, of course, that we are not idle after an infestation is found and steps are always taken if possible to exterminate it or to prevent its spread. Unfortunately, however, this is not always practical, due to the favorable surroundings of the infestation or ignorance of its existence until considerable damage has been done. Thus the burden of the entomologist is increased by additional correspondence, additional insect pests to combat and the necessity of obtaining additional funds for that purpose or stretching an already meager appropriation to cover it, to say nothing of the damage which many foreign insects are capable of doing.

What is occurring in New Jersey must to a certain extent be happening in other states, dependent, of course, on the amount of imported stock received. During the year 1914, 11,742 cases of nursery stock came into New Jersey from Europe and South America and during the spring of 1915, 5,405 cases were received. New Jersey, therefore, is in greater danger from foreign pests than most other states, but once established there, a natural spread to other states would finally take place. These recently found foreign pests established in New Jersey are not by any means the result of a laxity in the inspection service, as every precaution is taken that our funds will permit. In most cases they are insects which have entered undetected by the inspector, sometimes through his ignorance of foreign pests, sometimes on account of individual carelessness, but mostly on account of the impossibility of examining every leaf, twig, root and particle of soil around the roots of a plant and having anything left that will grow, especially when one is called upon to inspect hundreds of plants every

day. In other words, ordinary inspection will not keep out all foreign pests and extraordinary inspection would not be tolerated by importing firms or paid for by state governments. Therefore the only other way in which the danger from foreign insects can be reduced to a minimum is by a federal law prohibiting the importation of all nursery stock. This was suggested at last year's meeting of this body.

In order to determine how such a ruling would be received by New Jersey importers of nursery stock, most of them were interviewed along this line during the course of inspection work the past year and the majority were in favor of it or indifferent. This opinion, however, applies only to the importation of ornamental stock as very few imported fruit stocks enter New Jersey and very little fruit stock is grown. Their reasons for favoring such a measure were not by any means entomological but purely commercial. Some of the firms interviewed have built up organizations capable of growing their own stock and are therefore to a certain extent independent of foreign growers. Many said that they were forced to import certain plants because everybody else did and that they could not afford to stop even though the profit in such plants was small. Others complained of foreign shippers who, after supplying the regular trade, unloaded stock on the auction houses where it was sold considerably cheaper than they could import it for thereby making it possible for "fly by night" nurserymen and firms with no overhead charges to sell cheaper than they. Others spoke of the inferior goods imported by some department stores and sold to the unsuspecting public, a procedure which no reliable nursery firm could afford. Others were indifferent as long as all firms alike would be prohibited from importing stock.

All were agreed in that the sale of native plants would be accelerated, that the prices of certain plants would advance due to increased expense in growing them and that stock which could not be grown here on account of adverse climatic conditions, labor, poor soil, etc., the public would simply have to do without or take a substitute, also that it would be impossible to obtain plant novelties or new things.

The minority in favor of importations being continued consisted of firms not equipped to grow certain kinds of stock, department stores, men who depended upon auction houses for their supply of imported plants, and others who have been making a profit by importing and reselling stock. Thus, whether an importer was in favor of or against further importations hinged upon—would he lose money, could he grow the stock here profitably, could he grow something else to take its place? It is to be regretted, of course, that some persons would be seriously handicapped if further importation was prohibited, but

the main issue is—will the interests of the state be served best by imported nursery stock plus foreign pests or by no imported stock and no pests?

Since writing the above, two additional foreign species established in New Jersey have been identified. One of these is *Eucactophagus graphipterus* Champion, a weevil whose larva lives in soft bulbed orchids and is capable of doing considerable damage to such greenhouse stock. This came to us in orchid stock from Central America or the U. S. of Colombia. The other is a Tingitid from Japan, namely *Stephanitis azaleæ* Horv., which did considerable damage to hardy azaleas in various parts of the state during the past season, and which appears to be firmly entrenched. This species was introduced with azaleas imported directy from Japan and escaped detection until it had established itself over the entire state.

In closing I wish to express my indebtedness to the various specialists in the U. S. Bureau of Entomology, who through the courtesy of Dr. L. O. Howard identified many of the species mentioned.

IMPORTANT FOREIGN INSECT PESTS COLLECTED ON IMPORTED NURSERY STOCK IN 1915

By E. R. Sasscer

The condition of nursery stock offered for entry has unquestionably shown a marked improvement since the passage of the Plant Quarantine Act in 1912. This condition cannot be attributed to a falling off of importations during the present year, for, as shown in the accompanying table, the European exportations for 1915 exceed those of 1913 and 1914.

Table Showing Increase of Nursery Stock Offered for Entry During the Past Three Years

	1913		1914		1915	
	Nursery Stock	Seed, Pounds	Nursery Stock	Seed, Pounds	Nursery Stock	Seed, Pounds
Belgium	704,927		720,891	165,000	1,114,089	
England	2,578,174		2,267,285		3,914,901	
France	30,812,059		29,024,187	2,073	41,604,161	40,053½
Germany	1,360,398	7,020	194,186	1,049	177,994	821½
Holland	5,274,944		4,602,954		6,539,416	0

In spite of the increased European importations and the unsettled condition of the countries which export in bulk to the United States, nursery stock, for the most part, has been comparatively free from injurious insects during the current year. It is obvious, therefore,

that the Plant Quarantine Act, in addition to offering many advantages to the state inspectors, has, furthermore, indirectly served the purpose of strengthening the inspection service of foreign countries. However, undesirable insects continue to enter on imported plants and plant products, but the number is infinitesimal as compared with former years. Instead of collecting brown-tail nests and gipsy moth egg masses by the hundreds, they are now intercepted only on rare occasions and in limited numbers. This scarcity of recognized pests does not indicate that there are not others of equal importance, which should be kept out, and careful examination of all foreign stock should be continued with vigilance.

Unfortunately, there still appears to be a lack of funds in certain states to properly conduct the inspection of foreign plants, with the result that many small shipments, especially those containing florists' stock, are not examined. The repeated finding of gipsy moth egg clusters on azaleas would seem to justify a careful inspection of all imported field-grown plants. In view of the fact that letters of information listing all reported interceptions have been placed at the disposal of the inspectors at intervals throughout the year, only those pests which appear important will be briefly referred to at this time.

Seven nests of the brown-tail moth (*Euproctis chrysorrhœa* Linn.) have been collected on French nursery stock, and one nest on rose from Irleand. Egg clusters of the gipsy moth (*Porthetria dispar* Linn.) were taken on six shipments as follows: three on azaleas from Belgium; one on blue spruce from Holland; and two on cedar from Japan. No less than 1,105 larvæ of the European pine shoot moth (*Evetria buoliana* Schiffermiller) were detected on shipments of *Pinus mughus* and *P. montana* from Holland, and a single specimen of *E. resinella* was also taken on *P. mughus* from Holland.

A new species of *Tripopremnon* was collected in Irish potatoes from Peru. This is the fourth potato weevil [1] taken from Andean tubers, none of which are known to exist in the United States. Occurring as these insects do in the Andean region of South America, it is very probable that if once established in the States, these weevils may become a serious menace to the growing of Irish potatoes. Infested potatoes are riddled with galleries and rendered unfit for consumption.

Egg masses of the European tussock or vapourer moth (*Notolophus antiqua* Linn.) have continued to enter on various kinds of stock from France, Denmark, Holland, and England. A dagger moth (*Apatela auricoma* Fab.) has also been frequently reported on French nursery stock.

[1] Sasscer, E. R. and Pierce, W. D. [Proc. Entom. Soc. Wash., XV, 3, p. 143 (1913)]. Pierce, W. D. [Jn. Agric. Research I, p. 374 (1914)].

Orchids from Colombia and Venezuela have shown a slight infestation with *Tenthecoris bicolor* (Scott). The pine sawfly, *Diprion pini* (Linn.), was collected on four different occasions on *Pinus mughus*. This sawfly appears to rank as a pest of importance in Europe, and it would, no doubt, adapt itself readily to the conditions in America. A second sawfly, *Emphytus cinctus* (Linn.), has been collected in the stocks of roses from France. Cocoons of an undetermined sawfly have also been collected on spruce from Holland.

Banana plants from the Philippine Islands exhibited a severe infestation with the banana root-borer, *Sphenophorus* (*Cosmopolites*) *sordidus* Germ. When received, these plants were apparently healthy, but after remaining in quarantine for several months they commenced to die down, and on close examination the roots were found to be riddled by the larvæ of this banana borer. In addition to the banana borer, these plants were also infested with *Calandra remota* Sharp. Instances such as the above demonstrated the necessity of growing plants in quarantine where they can be under constant observation. As previously indicated, the plants when received were apparently healthy, and no external evidences of insect injury could be found.

Some 1,466 pear seedlings from France exhibited an infestation of the European pear scale, *Epidiaspis piricola* Del. G. This coccid is now established in a few of the states, but is not, as yet, well distributed, and an effort should be made to prevent its introduction and further dissemination. In addition to the pear scale, the following coccids have been collected on imported material.

Aonidia sp. on *Myrciaria edulis* from Brazil.
Aspidiotus palmæ Morg. & Ckll. on cocoanut from British Honduras.
Chrysomphalus perseæ (Comst.) on orchids from Venezuela and Guatemala.
Pseudaonidia articulatus (Morg.) on citrus cuttings from Philippine Islands.
Pseudaonidia paeoniæ (Ckll.) on azalea from Japan and Holland.
Targionia biformis (Ckll.) on orchids from Panama, Venezuela, and Brazil.
Chionaspis tegalensis Zehnt. on sugar cane from Java.
Chionaspis wistariæ Cooley on wistaria from Japan.
Lepidosaphes newsteadi (Sulc.) on *Sciadopitys verticillata* from Japan.
Leucaspis bambusæ Kuw. on bamboo from Japan.
Phenacaspis eugeniæ (Mask.) on ornamental plant from China.
Parlatoria theæ Ckll. on maple from Japan.
Parlatoria zizyphus (Lucas) on citrus cuttings from Philippine Islands. This scale is frequently collected on Mediterranean citrus fruits but is seldom detected on nursery stock.
Pinnaspis buxi (Bouché) on cocoanut from British Honduras.
Pseudococcus azaleæ (Tins.) on azalea from Japan.

In conclusion, it would seem opportune to raise the question of soil around the roots of plants, such as azaleas, rhododendrons, boxwood, etc. During the past year two insects, the European earwig

(*Forficula auricularia* Linn.), and the European mole cricket (*Gryllotalpa gryllotalpa* Linn.), have appeared as pests in the eastern states, which were, in all probability, introduced in soil around the roots of florists' stock. The former insect is now well established in Newport, R. I., and vicinity, and has been the subject of investigation by the Bureau of Entomology during the past season. In Europe this insect is not looked upon as a serious pest, and its depredations, in so far as injury to plants at Newport, have been comparatively negligible. However, its presence is objectionable, owing to the fact that the insects leave their shelter after dusk, often crawling over porches, and frequently, when frightened, seek shelter in the clothing of the occupants of the veranda. Furthermore, these insects crawl through the houses and conceal themselves under cushions, backs of chairs, closets, shoes, and, in fact, every conceivable place. The appearance of the European mole cricket in New Jersey was recently described by Mr. Harry B. Weiss.[1] As, in the case of the earwig, the mole cricket is not a serious pest in Europe, although at times it does occasion some injury to plants which happen to be in the line of the burrow of the insect. Elaterid and Lachnosterna larvæ have also been discovered in soil around imported stock. With such evidence as indicated above, does it not seem desirable to consider the question of soil around the roots? In other words, is it practicable to forward such stock without soil around the roots? In case this is not permissible, is there not a possibility of eliminating such soil pests by fumigating all imported material at the port of entry with hydrocyanic-acid gas in the presence of a partial vacuum.

INSPECTION FACILITIES IN THE DISTRICT OF COLUMBIA

By E. R. Sasscer.

Largely through the untiring efforts of the Office of Foreign Seed and Plant Introduction of the Bureau of Plant Industry, the much needed equipment for the inspection of imported nursery stock was installed during the current year. To emphasize the necessity of proper inspection facilities it will, perhaps, be well to briefly describe the nature of the material to be inspected.

The Office of Foreign Seed and Plant Introduction alone is constantly bringing in plants and plant products from all quarters of the globe, many of the packages originating in countries which have no system of inspection and of which we know little as regards insects and plant diseases. Although foreign official channels constitute an important

[1] Journal of Economic Entomology, Vol. VIII, No. 5, p. 500, 1915.

source from which new plants and plant products are imported, scores of packages are received from diplomatic and consular officials, botanical collectors, travelers, missionaries, and amateur plant lovers abroad. Moreover, the Office of Foreign Seed and Plant Introduction has its own trained agricultural explorers who travel through foreign countries studying the native flora and they secure and forward to this country such seeds and plants as seem promising. Other offices of the Department also import plants and plant products; for example, quantities of seeds and bulbs are brought in for congressional distribution. The office of Crop Physiology and Plant Breeding Investigations introduces new and promising citrus plants and seeds. The Offices of Cereal Investigations and Forage Crop Investigations bring in seeds of cereals and forage plants, and the Bureau of Forestry introduces tree seeds. In fact, it is safe to say that at one time or another practically every bureau of the Department of Agriculture introduces nursery stock of some description. It is obvious, therefore, that in order to properly inspect and safeguard such material adequate inspection facilities are essential. However, as a further protection many of the plants, after having passed the initial inspection, or after a definite period in quarantine, are grown at one of the four field stations maintained by the Office of Foreign Seed and Plant Introduction, and are again inspected at the time of distribution.

Method of Inspecting Imported Nursery Stock

No imported nursery stock is inspected until an inspection card has been prepared and placed with the unopened plants or plant products indicating the kind, quantity, and origin of the material, and, when possible, the proposed destination. Naturally, the latter is more or less dependent upon the findings of the pathological and entomological inspectors. In addition to the serial number assigned by the Office of Foreign Seed and Plant Introduction, each introduction receives a Federal Horticultural Board number, which is placed on the inspection cards. These numbers serve to identify the introduction at any time in the future and make immediately available all necessary information regarding its source, name, method of culture, etc., thus rendering it possible to have a connected history of the plants many years after their introduction.

Questionable seeds, cuttings, plants, buds, or bud sticks, or those harboring insects or diseases of any description, are either destroyed or subjected to disinfection and grown under observation in a specially screened quarantine greenhouse far removed from the area of cultivation.

Inspection House

The inspection house (Pl. 11, fig. 1) consists of an inspector's office and an inspection room. This house is enclosed by a high wire fence, and the gates and doors are always kept locked. Only those responsible for the proper conduct of the work are provided with keys. In special cases passes are issued to interested persons good for the day of issue only.

The inspector's office is 12 by 19 feet, and is provided with three windows, two skylights the entire width of the room, and three doors, one of which opens into the inspection room. Only such furniture as is necessary to care for the inspection records, etc., is kept in this office, and under no conditions is nursery stock inspected in this office.

The inspection room is 19 by 30 feet, and is provided with four windows, four skylights the entire width of the room, eight ventilators, and four doors, all of which are thoroughly screened with copper wire mesh (40 meshes to the inch). The floor and about three feet of the walls are made of concrete, the remainder of the walls being made of galvanized iron. It is possible, therefore, to thoroughly flush or syringe the floor and walls with water or a disinfectant without fear of damage.

The furnishings of the inspection room consist of five white enameled tables on wheels on which is placed the material for inspection, four white enameled stools, three white enameled refrigerators (used to safeguard perishable material), a small sterilizer, a stove, a sink for washing the hands, scales, and white enameled trays for sterilizing small quantities of seed, cuttings, etc., with bichloride of mercury, and one white enameled bucket containing a weak solution of bichloride of mercury for washing the hands after handling suspicious material. Long white coats are always worn when inspecting material. Soiled coats are kept in a galvanized iron bucket until they have been thoroughly disinfected and laundered. The inspection room is cleaned daily and fumigated or washed down with formaldehyde as the occasion demands. (See Plate 12.)

The quarantine greenhouse is 70 feet long by 20 feet wide, and is divided into 14 units, six of which are 14 feet by 7 feet four inches, and eight of which are 7 feet 8 inches by 7 feet four inches. A three-foot corridor extends the entire length of the structure. To enter a unit from the corridor it is necessary to pass through a vestibule 3 feet by 3 feet which is provided with two doors, one opening into the corridor and the other into the unit. All doors and ventilators are thoroughly screened with the copper wire previously described. The ventilators are so arranged that they can be controlled from the corridor, thus

obviating the necessity of entering the units to adjust the ventilators. Furthermore, the ventilators, in addition to being screened, open into the corridor and not directly out of doors, thus reducing to a minimum the possibility of a wind storm injuring the plants or permitting the escape of insects by blowing off the opened ventilators of the units. The corridor is ventilated at the apex of the room by the usual type of ventilators used on greenhouses. To secure proper circulation each unit is also provided with a small sliding window 10 inches by 16 inches thoroughly screened with copper wire mesh. The sill of each window is eight inches from the floor. These units are so arranged that any one can be fumigated independent of the others.

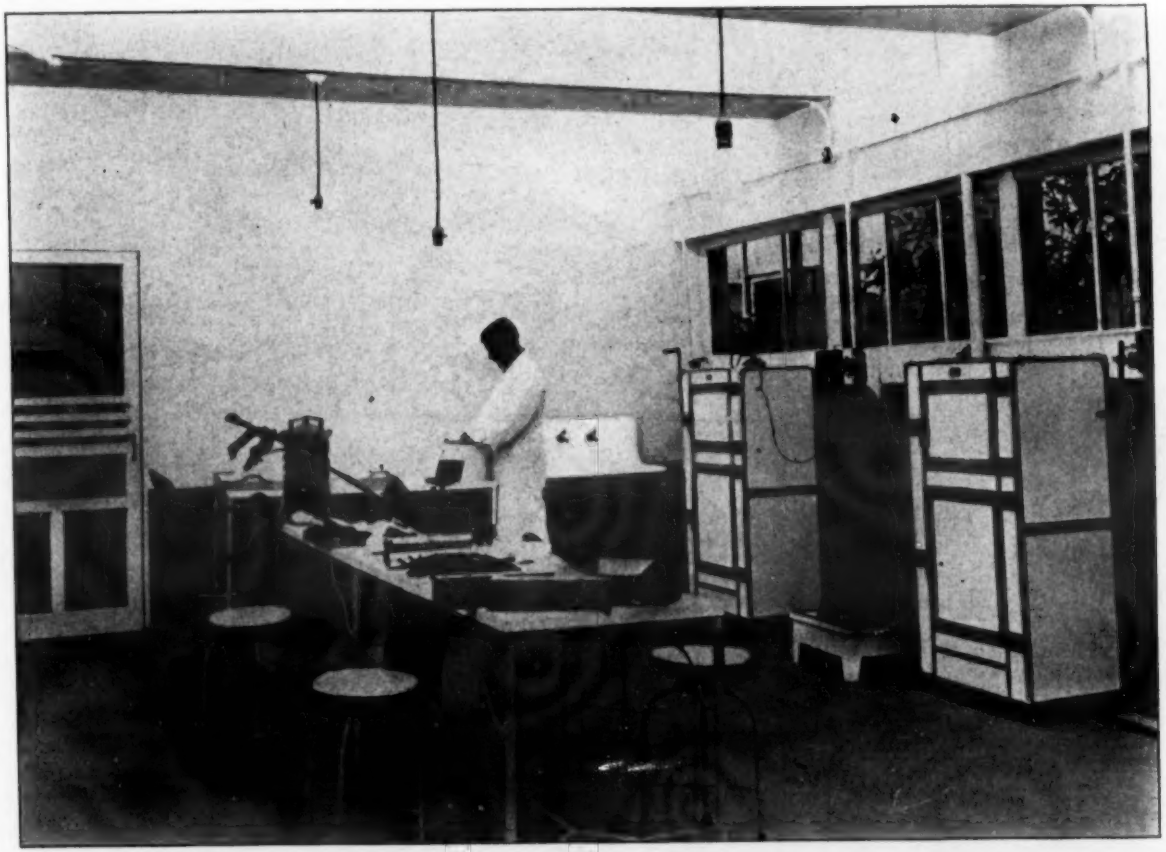
A record of the contents of each unit is suspended near the outside of the door entering the vestibule of each unit from the corridor. This record indicates the Federal Horticultural Board number, date of quarantine, name of plant or plants, origin, object of quarantine, and prescribed treatment. Plants are not removed from a unit or new plants substituted without the approval of an inspector of the Federal Horticultural Board. Long white coats are used by anyone entering the units.

Two additional units, 14 by 20 feet and 18 by 20 feet, are maintained for the purpose of carrying material released from quarantine and awaiting orders for distribution.

Description of Apparatus Used for Sterilizing Plants and Plant Products

"Briefly, this apparatus consists of a fumigation chamber or retort [Plate 13] (A), an auxiliary chamber or generator (B) for the generation of the gas, and an air pump (C). An additional air pump (D) is also a part of this apparatus, although not necessary for fumigation. One end of the fumigation chamber or retort is permanently closed, while the other end is provided with a heavy iron door swung on a hinge and held in place by six clamps. The gasket which is embedded in the door comes in close contact with the flange of the retort, and when properly greased and clamped prevents air from entering the chamber during an exposure. This retort lies with its longest axis in a horizontal position. On the upper side of the retort there are four openings: The one nearest the door (1) is provided with a vacuum gauge, which registers the degrees in pressure in units equivalent to inches of mercury; the second opening (2) is fitted to an exhaust pipe which is attached to the air pump (C), the exhaust leaving the pump at 2*a*; the third opening (3) is used to permit the air to enter the chamber at the completion of an experiment, while the fourth opening (4) is fitted to a pipe which leads to the

Inspection room, quarantine house and grounds



Interior of inspection room. Sterilizing hands. See refrigerators, steam sterilizer, etc.

Fumigating apparatus

auxiliary tank or generator (B) in which the gas is generated. The pipe leading from the fourth opening to the auxiliary or generator is provided with a gas cock and three enlargements, 4*a*, 4*b*, and 4*c* (the latter is not shown in the photograph). Two of these enlargements contain sodium cyanide, and the third glass wool. The object of the sodium cyanide and glass wool is to pick up any free sulphuric acid which may be mechanically drawn from the generator when the gas is permitted to enter the fumigation chamber. The auxiliary or generator (B) is so arranged that it can be used as a generating tank or as a fumigating chamber, by closing the gas cock just above the cylinder. The exhaust pipe which leads from the generator to the small vacuum pump (D) is shown as figure 9. No. 5 is a tubulature used in introducing the chemicals into the generator. No. 8 is a pipe which carries water to cool the air pump (C), and No. 10 is the cooling pipe for the small air pump (D). No. 11 is the pipe which carries the exhaust from the small air pump, and No. 6 is a combination pressure and vacuum gauge. No, 7 is a rheostat.

The material to be fumigated is placed in the retort (A), the door closed and clamped, and the air exhausted until the gauge registers about 26 inches; that is, the air in the chamber is exhausted until the pressure is the equivalent of about 5 inches of mercury. At this stage the suction is cut off, and the gas is generated in the auxiliary chamber (B) and introduced into the fumigation chamber through the pipe (4). The gas may be generated in one of two ways. The cyanide may be placed in the jar within the generator, the door closed, and the acid and water introduced through the tubulature (5), or the acid may be placed in the jar within the generator and the cyanide in solution introduced through the tubulature (5). The latter method is preferable, especially where a glass tubulature is employed, as it eliminates all possibility of breakage of glass by the heat generated from the combination acid and water. In fact, to prevent breakage, it has been found advisable to cool the acid and water, which reduces the yield of gas. Where the cyanide in solution is introduced through the tubulature, no heat is generated until the solution comes in contact with the acid in the generator. This method has an additional advantage in that the yield of gas is increased."

The material to be disinfected may be fumigated in either of two ways, namely, by generating the gas in the presence of a partial vacuum and holding the vacuum for a definite period, or by generating the gas in the presence of a partial vacuum and returning to normal atmospheric pressure upon the completion of the generation.

NURSERY INSPECTION IN FLORIDA

By F. M. O'Byrne

To the ordinary observer the present nursery inspection requirements in Florida may seem to be far fetched and over exacting. But they are but the logical outgrowth of a trying experience through which we are now passing and each step has been necessitated by some actual and costly experience.

It will not be possible in the short time at my disposal to more than mention the steps which have led us to our present position. Quite briefly they are as follows. In the years of 1911–12 there were imported into the state of Florida over 35,000 diseased citrus seedlings. These came from a nursery in another state, which nursery had been inspected and certified as apparently free from especially injurious insect pests and diseases. This is no reflection on the other state, for this disease was new to them and had not as yet been recognized as a new disease but was thought to be an unusual form of an old, well-known malady.

This new disease was especially virulent on grape-fruit trees. The nursery first found to be infected had many branches in the state. These branches were grouped under two separate managements. The particular branch showing the disease was placed under quarantine but shipments proceeded from the other branches. Somewhat later another branch controlled by the same management was found to be diseased. It was immediately quarantined but still shipment proceeded from four other branches. We did not know, as yet, that this disease was dreadfully and terribly infectious and could be carried on the hands or clothing of an inspector or workman. Nor did we know, as yet, that under certain conditions the disease could apparently remain dormant on infected trees for a year or more before becoming visible to an inspector. The nurseries always claimed that they had been exercising every care to protect the other branches from becoming infected and the department, especially in the light of the weak law under which they were working, did not feel that they could quarantine a branch which was widely separated from the others and worked largely by a separate crew of men, until that particular branch showed signs of the disease. One after another, each of these branches showed the disease and in August of 1915, this malady was discovered in their last apparently unaffected branch.

It was learned that trees in certain of these shipments had developed the disease and, as it was the intention of the authorities to erad-

icate the trouble, it became necessary to ask the nursery concern to prepare an accurate list of all the shipments which they had made since the original discovery of the trouble, that they could be traced down and inspected. These nursery concerns were facing a grave crisis, income was cut off and expenses soaring, so that they were laying off all of the help they could. Naturally they were slow in preparing these lists of shipments and many inaccuracies were found to occur. As a result, the work of inspection was retarded and hampered severely. Suppose that these nurseries had gone bankrupt and the proprietors refused to prepare such a list, or suppose that a fire had destroyed their invoices, the result would have been terrible. We would have then been helpless and would probably have had this disease fastened upon us forever.

As a result of the foregoing experience, we learned that we should have on file in the office of the Nursery Inspector, an accurate record of the movement of each and every plant that could be classed as nursery stock, whether moving into from without the state or merely moving from place to place within the state, whether grown by a nurseryman or a person not regularly in the business, whether sold, given away or merely moved from one piece of property to the other by the owner. The question was to evolve a system that was ironclad, easy of enforcement and not too burdensome on the nursery. The system adopted follows:

Each person who wishes to move any nursery stock in Florida shall apply to the Nursery Inspector for inspection. If the stock is found to be sufficiently clean a certificate is made out covering the stock inspected. This certificate is filed in the office of the Nursery Inspector, and the owner of the stock is privileged to purchase, through the Nursery Inspector, certificate tags bearing practically the same wording as the Certificate of Inspection.

One, and only one, of these tags must be attached to each and every package of nursery stock shipped. They are consecutively numbered and a record is kept of the numbers furnished to each and every person or firm, who are required to account for every tag they received, giving the name and address of the purchaser of the bundle of stock upon which a tag is used, the name and address of the person to whom shipped, and an exact description of the contents together with the number of the certificate tag used thereon. To do this they merely make out their invoices in triplicate instead of in duplicate as heretofore. This invoice shows the number of the certificate tag used on the shipment and one of the copies is sent to the office of the Nursery Inspector for permanent filing. Shipments of nursery stock which do not meet these requirements are illegal.

Nurseries without the state are allowed to purchase such tags upon the filing in our office of a satisfactory Certificate of Inspection. In all other respects they must meet the requirements imposed upon our own nurserymen.

Formerly, many of the nurseries were in the habit of soliciting club orders or of shipping to agents for redistribution. This defeats the end for which we are working. It was therefore necessary to require that such orders be packed individually and so billed and tagged. Then, if the nursery so desires, they may pack all of these small orders into one large one and ship to one person for redistribution. By so doing, we have in our office a complete record of the final destination of all such orders.

As has been said, we have been dealing with a new disease, which was at first mistaken for a peculiar form of an old well-known disease. Before we learned that it was very infectious, our inspectors undoubtedly spread the trouble while making inspections. This will never do. We must not lay ourselves liable to such a damaging charge again. But we do not know at what time another new disease may appear. Therefore the only safe course is to treat each nursery that we are inspecting, as if it contained some new and highly infectious disease. We therefore require each inspector to wear an inspection suit while inspecting a nursery. These suits are made of musaline, in one piece, and cover the entire body like a surgeon's operating suit. When an inspector finishes inspecting a nursery he removes the suit and sterilizes it completely by immersing it in 1 to 1,000 corrosive sublimate solution. He also sterilizes his hat, face, hands, and feet regardless of the condition in which the nursery was found to be. In order that the inspector may have a suitable vessel in which to mix the solution, they are each provided with a folding canvas bucket.

Failure to sterilize immediately on leaving a nursery makes an inspector liable to discharge.

The foregoing is but a rough outline of our system and of necessity omits many details. I would, of course, be glad to answer any questions. Our whole system may be summed up as follows: We aim to have a system of checking so that we may verify the statement of each inspector or nurseryman. We also must have a plain and accurate record of the movement of each piece of nursery stock planted in the state. The invoices, we require, provide a permanent and accurate record whereby we may trace the movement of all stock emanating from every nursery in the state. Should a new disease develop we have *instantly* at our command a record of shipments made from any diseased nursery so that diseased stock may be traced down and destroyed or quarantined.

THE OHIO INSPECTION SYSTEM

By N. E. SHAW, *Columbus, O.*

Entomological work in Ohio, under state control, is placed with three separate departments each having well defined duties to perform. All research work is done by the Entomological Department of the Experiment Station at Wooster; all instructional work in entomology comes under the Zoölogical Department at the University and the enforcement of inspection laws relating to insect control is placed with the Bureau of Nursery and Orchard Inspection of the Board of Agriculture.

A definite understanding as to the duties of each Division exists among the different heads yet there is coöperation of effort on all problems which concern alike the several divisions and when best results can be obtained by a combination of effort.

Nursery and orchard inspection work has existed as a separate Bureau since 1902 when the work was separated from the entomological work at the Experiment Station and placed under the direction of Mr. A. F. Burgess. The foundation of the inspection system which we are following today, with but slight changes, was prepared by Mr. Burgess.

Our law provides for the annual inspection of nurseries and as many additional inspections as may be thought necessary. This work is commenced about July 1, of each year, and a careful examination of the different nurseries is made row by row. With the consent of the nurseryman all stocks showing infestation by San José scale are broken over by the inspector and are promptly removed from the blocks by the nurseryman and burned. Should he object to the destruction of infested trees, he has the privilege under the Ohio law to apply such treatment as may be ordered. After this work has been complied with he again applies for the inspection of his nursery. He is permitted by provisions of the law to dispose of, within the state and with the consent of the purchaser, scale-marked nursery stock after treatment has been applied and the stock has been officially fumigated. But few nurserymen have ever availed themselves of this provision. The great majority of them prefer to have all infested stocks found by inspectors broken and removed from the blocks.

Where infested blocks have been found one or two additional inspections are made before shipping time, certificates are issued and the stock is fumigated under the supervision of inspectors and allowed to go out to the trade. Additional inspections are made of stock at digging time, either as it is lifted in the field or when

brought to the packing grounds to be fumigated. By these several inspections we endeavor to locate all infested trees, and then take the extra precaution of supervising fumigation work.

¶ An inspection is also made during the summer of premises adjacent to blocks of nursery stock and treatment of infested trees is required so far as practical and where there is danger, by the location of infested trees, of their being a source of infestation to nursery blocks. An inspection is again made of these premises during the dormant period and a thorough spraying is enforced. Should owners neglect to apply this treatment in specified time, the work is done under the supervision of inspectors and the costs placed upon the tax duplicate of the owner.

Several hundred dollars worth of this kind of work has often been done under our supervision around different nurseries.

We have never strongly favored, except under unusual conditions and in extreme cases, the summer treatment of nursery blocks. With a slight infestation we prefer to carefully inspect and re-inspect such blocks, remove all infested trees and rely upon our fumigation system for the protection of the purchaser.

When fumigation work is left to the nurseryman at least one and quite often all of the essentials necessary in thorough fumigation are liable to be overlooked and disregarded. There are a number of things which will prevent even the most careful and conscientious nurseryman from performing this work as it should be done for best results. I feel sure that Mr. Burgess in his work in Ohio early realized the necessity for official supervision of this work. It was no easy task to get our nurserymen accustomed to this plan. When first adopted it caused considerable delay to the nurserymen while waiting for inspectors to supervise the work. After the system became well organized and the nurserymen had become accustomed to the practice, it was carried out with but little delay to them. Such work is made easily possible in Ohio by the excellent transportation system of the state and largely by the fact that our larger nurseries are grouped in several sections of the state. One or more inspectors are located in each section. Nurserymen keep them advised by phone of probable time that they will be needed and in this way they can plan their work and render prompt service. One inspector can usually take care of those scattered about the state.

Before the shipping season begins, nurserymen are required to go over their fumigating houses carefully and put them in perfect order. Inspectors then test each house with smoke and refuse to use any that have not been made perfectly gas tight. We often find that a house gets out of repair during the shipping season and it is immediately ordered placed in condition. The weakness, of course, is usually at

the doors and when continually used it is necessary to watch them closely.

The arrangement of stock in a fumigator so that it will be thoroughly exposed to the gas is not easily controlled.

Most of the larger nurserymen arrange to drive a wagon load of stock into the house. This allows in our judgment of very good exposure to the gas because the stock is well above the floor and the gas can easily penetrate to all parts of it.

Where stock is unloaded and placed in the house there is a tendency on the part of the nurserymen to want to pack it too tightly, often placing the roots on portions of the stems or trunks so that they are covered and the gas may not have free access to the insects. We insist upon an open floor usually built on two by fours or two by sixes so that gas can thoroughly reach the stock from below. It is necessary once or twice during a shipping season to take out these floors, which are usually built in sections, and remove the dirt which has shaken off from the roots and has accumulated until it fills up the open space below floor level.

We found, before supervision of this work was taken up, that the time required for the exposure was often cut in two and sometimes stock had been exposed but ten or fifteen minutes before opening the house. This is a frequent temptation when rush orders are received and cars are waiting to be loaded.

It was early found that potassium cyanide being secured by nurserymen in their several localities varied considerably in purity. In some tests that were made the per cent of potassium cyanide varied from 31.05 to 100. The practice was then inaugurated of having nurserymen place their orders through our office where this material could be secured from sources on which we could have some check and know that the proper grade was being sent out. Supervision of this work has also permitted us to know that potassium cyanide after being received by the nurserymen was kept in such a manner that it could not deteriorate. Even with this precaution we have occasionally secured inferior lots of potassium cyanide. Last year when a greater scarcity of this material was evident, we found that several shipments of the inferior grades had been made to nurserymen and it was necessary to refuse its use. During the present year we have used nothing but sodium cyanide.

This, in general, is an outline of the way in which we are handling nursery inspection and fumigation in Ohio. We are not always able to carry it out as thoroughly as we would like to do. Every inspector knows of the different things which arise to interfere with the best laid plans. It must be remembered that during a portion of the time

devoted to this work we are receiving large quantities of imported shipments of nursery stock from abroad which we feel must be given very prompt and careful attention. We have also had for past two years a gypsy moth outbreak to contend with and this, of course, has necessitated strict attention.

San José scale is a well established pest in the state of Ohio. In three-fourths of the state or throughout the level portions, the infestation is general and it is the exception to find an orchard free from this insect. In the other portion of the state which is hilly, it is rarely that an orchard is found infested with San José scale, and in this section are located our largest commercial apple orchards. In the infested area are many localities and many orchards where scale is under perfect control and is causing no particular injury or loss. This is due to the extensive campaign which is being waged for the proper treatment of farm orchards for insect control.

Over 11,000 people attended our orchard demonstrations during the present year.

So far as Ohio is concerned, we would feel that we were giving our planters of Ohio grown nursery stock adequate protection by carefully supervising the fumigation of nursery stock, destroying those stocks which are more than slightly infested and thus possibly might be weakened from scale attack. It seems rather unreasonable, in view of conditions as we know them to exist in Ohio and in the eastern and central states as well, to require the wholesale destruction of infested stock. I do not mean to say that we should recede at all from our position of having nurserymen use every precaution to protect their stock from infestation. The fact that our nurserymen have not taken advantage of the Ohio provision allowing them to dispose of scale marked stock within the state, would indicate that they are not inclined to take any backward steps in fighting San José scale.

We would feel perfectly safe in accepting from other states, stocks which would be given the same careful fumigation treatment that we are attempting to carry out in Ohio. We would feel that purchasers of nursery stock in this state were getting better protection than they are under present methods, as indicated by our findings this year.

At four of our nurseries receiving stock from nurseries located in seven other states within a radius of 400 miles and less of Ohio, we have found over 30,000 stock infested with San José scale and infected by crown gall in about equal numbers. In one shipment of 70,000 trees the infested and infected trees amounted to 15 per cent of the entire shipment. Bear in mind that these findings were made at four of our nurseries. If it were possible to inspect the vast quantities of stock which came into the state through agents and dealers, the count would be much larger. These inspections of incoming stock at the

nurseries are of course made for the protection of our nurserymen and our own certificate in order that when some of the same stock is again re-shipped back into the states from whence it came, we may possibly be relieved of the embarrassment of receiving a notice of an infested shipment.

I do not wish to give the impression by what has been said in the forepart of this paper that Ohio is not guilty of sending out infested or at least scale-marked stock. We know that we are because we have been told so and we like to have this information, when such shipments are made. One state has felt it necessary to send her inspector here to examine shipments of some large dealers from that state who secure and pack their stock here. That state happens to be one of the seven already mentioned and the distribution of San José scale is general throughout that state. We know this to be a fact because several of our inspectors have worked there in years gone by.

Here is what I feel that we should be doing in Ohio. Inspect carefully our nurseries and their surroundings, thoroughly fumigate their stock before it is disposed of and inspect every shipment of nursery stock entering the state. All of this seems necessary for the protection of our fruit-growing interests which our law was created to serve and for which funds are appropriated. What we are doing is spending the major part of our time in inspecting and re-inspecting our nursery stock in the field and on the packing grounds, inspecting stock which they receive from other states, all in order that the last insignificant little scale may be eliminated and our nurserymen's business be protected from injury by being discriminated against in some other state; giving our greatest efforts so far as Ohio is concerned to a relatively small number of men rather than our large number of commercial orchardists, owners of farm orchards and every citizen of the state who plants a tree or shrub.

I belive that inspection officials, in those states where San José scale is not a well established pest, are right in using the utmost care in preventing infested shipments from entering their states, but it does seem that a different attitude should prevail in those states where conditions are similar to those in Ohio.

THE STATE HORTICULTURAL INSPECTORS AND THE WHITE PINE BLISTER RUST PROBLEM

By Perley Spaulding

The white pine blister rust is a disease of five-leaved pines which was brought into this country from Europe some ten or fifteen years ago in imported lots of white pine seedlings. The parasitic fungus

causing this disease has an alternate stage of growth upon the leaves of wild and cultivated currants and gooseberries, that is, the genus Ribes. Ever since 1909, when the disease was first found in this country on pines, an effort has been made to eradicate this disease from this country because of the very serious danger with which it threatens our white pines. From 1909 to 1914, inclusive, there were eleven distinct cases where the disease spread from pines to neighboring Ribes, thus showing very emphatically the extreme danger of its becoming permanently established in this country. In some of these cases the disease also spread back to the neighboring pines from the infected Ribes, thus completing the entire life cycle of the parasite. In 1915, owing to the prolonged wet weather and accompanying winds, there were twelve such outbreaks of this disease. At present we have then a number of areas varying in size from a few acres up to an area in one case of some five hundred square miles, where the disease has spread upon Ribes and threatens to become permanently established. The disease cannot spread in any locality unless both kinds of hosts are present in that locality, that is, the removal of either one stops the spread of the disease.

The foresters of the white pine region have become thoroughly alarmed concerning the situation. It seems to be entirely practical to stop the spread of this disease in these infected localities by the mere removal of wild and cultivated Ribes within them and for some distance outside. This appears to be a far more practical procedure than that of the removal of gipsy and brown tail moths from trees up to 80 or 90 feet in height, which is being performed every year now in some sections.

In order to carry on this removal of Ribes, however, it is absolutely necessary that the horticultural inspectors of the various states shall have absolute power with which to compel uniform action on the part of the owners, if such uniform action cannot be otherwise secured. This matter is one which is sure to come to you within a very few years, and is even now staring some in the face.

Another matter which would go far toward reducing the danger from this disease is the quarantine of black currant, *Ribes nigrum*, so that it cannot be shipped from state to state. Such quarantine power also is important in preventing the shipment of white pines from one state to another. These two things every state horticultural inspector ought to try to have incorporated in his law, as he is sure sooner or later to find them necessary to his carrying on efficient work.

NOTES ON THE RELATION OF INSECTS TO THE SPREAD OF THE WILT DISEASE[1]

By H. W. ALLEN, *Gipsy Moth Laboratory, Melrose Highlands, Mass.*

During the caterpillar stages, vast numbers of the gipsy moth die of a disease known as the "wilt." This affection is typical of a group of insect diseases termed "wilt" or "polyhedral" diseases and which are characterized by extensive breaking down of the body tissue, and the formation of microscopic, angular bodies known as "polyhedra." Polyhedra invariably occur in large numbers in diseased insects and are considered to be reaction products. The disease is believed to be produced by infection of the alimentary canal and to be caused by a filterable virus, presumably an organism and very much smaller than the polyhedra.

Victims of the disease reach an advanced stage of disintegration soon after death. Dead caterpillars often occur in great abundance, and, as would be expected, attract many insect scavengers. Sarcophagidæ, in particular, are attracted in abundance and breed freely in the dead larvæ and pupæ resulting from the disease.

Very little is known of how the infection causing the disease is spread. Experiments by Glaser and Chapman[2] have indicated that it is not essentially a wind-borne disease. The presence of scavengers in connection with the disease suggested that they might be carriers of the infection and agents in the spread of the disease. It was believed that if these insects could be shown to be carriers of polyhedra, it would indicate that they might also be carriers of the virus and hence in all probability distributors of the disease. Accordingly, an effort was made to determine this in connection with other field work on the wilt disease conducted at Lunenburg, Mass., during the past summer. Although the work was preliminary, and not conclusive in indicating that the disease is insect-borne, it has shown that insects commonly act as carriers of polyhedral bodies and suggests that they also in all probability act as carriers and distributors of the disease.

In securing the record, specimens observed to have been in direct contact with gipsy moth larvæ and pupæ that had recently died as a result of the wilt disease, were collected in the field. These were sent to Messrs. Glaser and Chapman, of this Bureau, for examination and we are indebted to them for the findings in regard to polyhedra. Only such specimens were taken as were observed to have been

[1] Published by permission of the Chief of the U. S. Bureau of Entomology.

[2] JOUR. OF ECONOMIC ENT., Vol. VI, No. 6, pp. 479–488.

in contact with insects dead of the wilt. The active Sarcophagid flies, after leaving such material, were captured with a clean net and introduced into small, clean vials. Other, less active specimens were secured in glass vials after they had left a smear of wilt. The specimens were killed by placing the vials, plugged with clean cotton, in a cyanide jar. The *Calosoma sycophanta* larvæ taken, were removed from a mass of gipsy moth larvæ and pupæ which was moist with the fluid oozing from their dead bodies. Great care was used in collecting the specimens, so that they were secured bearing no more wilt contamination on their bodies than they would naturally carry when free and unmolested.

Polyhedra were found on a majority of the specimens captured. Feet and mouthparts especially were examined and both found to harbor polyhedra.

In collecting specimens, insect scavengers were most frequently found in contact with larvæ and pupæ dead of the wilt, and of these, certain Sarcophagidæ were by far the most abundant. Adult Sarcophagids were repeatedly observed walking over, feeding or depositing maggots on diseased material. They were often abundant in the tree-tops and on warm, bright days were very active, flying rapidly from leaf to leaf. They appeared early in May, and were abundant until the end of the pupal stage of the gipsy moth which terminates the epidemic of wilt. A number of Sarcophagid adults, found walking over or feeding on diseased material, were taken, and nearly all were found to be carrying polyhedra on their feet or mouthparts, or on both. Their abundance, the fact that they frequent wilt, that they are carriers of polyhedra, and are repeatedly found on the foliage upon which gipsy moth larvæ feed, all strongly suggests that the Sarcophagidæ do work of considerable importance in distributing the disease.

Other insects were occasionally observed in contact with the disease. Adult Elaterids were twice found feeding on gipsy larvæ that had died of the wilt, and on both occasions were found to carry polyhedra. Polyhedra were also found on two adult Coccinellidæ that were taken under similar circumstances. An unknown Hemipteron, and an unknown beetle larva taken wading through a fresh smear of wilt, and three *Calosoma sycophanta* larvæ captured in association with wilt material were all found to carry polyhedra. Polyhedra were also found to be carried by minute red mites. Ants were often observed on trees bearing the bodies of many larvæ and pupæ dead of the wilt. They occasionally fed on this material, but more commonly seemed to avoid it. The ants were collected several times and polyhedra were found once on an insect that had been captured crossing a dried smear of wilt.

Unfortunately a more specific determination of the insects found to be carriers of polyhedra cannot be given at this time. The nature of the experiment made it impracticable to determine the specimens until after they had been examined for polyhedra. After examination, many were badly mutilated, and owing to a misunderstanding were discarded. It is to be remembered that the work done was only preliminary and was planned to indicate whether insects ever acted as carriers of polyhedra. Now that it has been clearly shown that they commonly do carry polyhedra, it is expected to continue the work another season and among other things to determine more definitely the insects acting in that capacity.

To sum up, little is known of how the infection causing the wilt disease of the gipsy moth is distributed. It is evidently not primarily a wind-borne disease. Certain insects found abundantly in association with the disease, frequent the foliage of trees and are known to carry polyhedra after contact with the wilt, which indicates that they may assist in spreading the infection.

TWO NEW MONOPHLEBINE COCCIDÆ FROM THE PHILIPPINE ISLANDS

By T. D. A. Cockerell, *Boulder, Colorado.*

The Philippine Islands appear to be quite rich in Monophlebines; in addition to six species already recorded (all but one apparently endemic), the following two, received from Prof. C. F. Baker, must be described:

Llaveia benguetensis n. sp.

Male.—Length 4.5 mm., exclusive of abdominal processes; wings about 7 mm. long, black, with the usual venation and two hyaline lines; costal field dark reddish-brown; head and thorax black, the mesothorax shining, region just below wings dark red and dull; mesosternum enlarged, convex, polished black; eyes very prominent, constricted at base, placed at lower anterior corners of head; antennæ black, with very long black hairs; third joint with three nodes; legs black; abdomen broad, dark red, with the dorsal region strongly suffused with black, apex deeply emarginate; six long slender fleshy abdominal processes, the first pair shorter than the others, which are subequal, and are a little longer than the diameter of abdomen.

Hab.—Baguio, Benguet (Baker 5341). Resembles the Indian *L. stebbingi* (green), but is not at all dusted with mealy powder, and the distance between the second and third abdominal processes at base is very much greater. *L. fabricii* (Westwood), from Sumatra, is apparently, as Green remarks, another species of the same general type.

Drosicha palavanica n. sp.

Male.—Length about 3.5 mm., exclusive of abdominal processes; wings nearly 5 mm. long, black, with the usual venation and two hyaline lines; costal field dark

sepia; head and thorax dark red, front and mesothorax black; antennæ black, with long black hairs; third joint with three nodes; legs black; abdomen almost as broad as long, red, strongly suffused with blackish dorsally, with ten red fleshy processes, successively longer, each with long black hairs at end; the last processes are scarcely over one mm. long.

Hab.—P. Princesa, Palawan. The terminal caudal processes are much longer than in *D. maskelli* (Ckll.), but not so long as in *D. burmeisteri* (Westw.). Structurally, the species is like *D. leachii* (Westw.), but that is much larger. The male monophlebids now known from the Philippines may be tabulated thus:

Costal region broadly brilliant red; abdomen with six processes ..... *L. sanguinea* Ckll.

Costal region not red 1

1. Abdomen with six processes ..... *L. benguetensis* Ckll.
   Abdomen with eight processes ..... *L. luzonica* Ckll.
   Abdomen with ten processes ..... *D. palavanica* Ckll.

In addition to these, I have specimens with eight abdominal processes, which are red, not plumbeous or blackish as in *L. luzonica*, from Mt. Makiling (Luzon.). Batuan (Mindanao), and Cuernos Mts. (Negros). These differ slightly from each other, and probably represent new species, but it is desirable to learn more about them. From Baguio (Benguat) comes a male *Icerya;* easily known from all the above by its small size (wings less than 3 mm. long), abdomen with long bristles, but without long fleshy processes. *Icerya candida* Ckll. and *I. seychellarum* (Westw.) are known from the Philippines in the female sex.

Three Important Insect Pests have appeared in Minnesota during the past season, two for the first time. The Hessian fly (*Mayetiola destructor*) was reported in the autumn of 1914 near Minneapolis. Prompt measures were taken for the suppression of this small outbreak, but a few "flaxseeds" were found this time near the University Farm in October, 1915. The last appearance of this insect in Minnesota was in 1903.

The Western corn root-worm (*Diabrotica longicornis*) has been reported in Minnesota for the first time during the past summer, appearing in several widely separated localities in the southern quarter of the state.

The corn root-louse (*Aphis maidi-radicis*) has also never been mentioned in any of the entomological reports of Minnesota. Last summer it caused extensive loss to corn in three widely separated localities in southern and south-western Minnesota.

C. W. Howard,

November 29, 1915. *University Farm, St. Paul, Minn.*

Labeling Parasite Material. Mr. Harry S. Smith, of Sacramento, Cal., noting my suggestion in the last Monthly Letter of the Bureau of Entomology in regard to labeling of parasites, suggests that where one is not absolutely certain of the host the label should be qualified in some way. He has adopted the plan of using the word "material." For example, if he has a box of scale insects of a certain species and rears parasites from it, he labels the parasites, say, "From *Saissetia oleæ* material." There are so many times a few individuals of some other species present but not visible that this is frequently a cause of erroneous records, and such a label as suggested immediately puts the parasitologist on his guard.

L. O. H.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

FEBRUARY, 1916

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, as far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photoengravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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History has been made in the last few weeks. We now have a fully organized Pacific Slope Branch. If it was a good idea, it should be consummated at once, and after due consideration, we are convinced that the action taken will receive the hearty approval of the entire membership. In reality, the scope of the organization has not been extended. It amounts, in final analysis, to a practical recognition of the difficulties the western entomologist experiences in attending meetings in the east. We extend to our western confreres the right hand of fellowship. May the bonds strengthen as time passes.

Entomology becomes economic in proportion to the saving effected. The account of the Hessian fly train and the discussion of county coöperation against this pest are both striking examples of applied or economic entomology—the type that actually saves something. Knowledge applied is power; knowledge unused should be placed in the same category as the idle talent and may even be the occasion of merited rebuke. It does not follow that the entomologist without a special train, or the more or less general coöperation of a county, is remiss. He may be and we think most are accomplishing much in somewhat quieter ways. The extension entomologist, a term which has come into use within a few years, is a most useful individual and is able through specialization along one line to meet and show a very large number just how the best results can be secured. All entomologists must resort to such methods if they would secure

satisfactory results. It is largely a question of apportioning effort and here local conditions have an important bearing. The answer in no two cases will be exactly the same and the amount of time given to each line of effort must vary with the season and change more or less from year to year.

The training of the economic entomologist has received considerable attention at the hands of both teachers and workers. There is no question but that a liberal training with all that it implies is a most excellent foundation for a professional career. There are a number of related, special sciences of value to the entomologist and they likewise require close application for their mastery; not to mention the exacting requirements of entomology itself—a science dealing with an immense number of insects presenting extraordinarily wide variations in biology, ecology and adaptability. The well equipped entomologist should have several years of practical experience in both field and laboratory work, using the latter adjective in a somewhat general sense. This all takes time and it is doubtful if the best university undergraduate and graduate courses combined can cover all this ground in an entirely satisfactory manner. Furthermore, not every man can afford to devote the necessary time to cover the ground indicated above. In the ultimate analysis there must be more or less compromising on both sides of the line and, generally speaking, we believe that it is possible to cover only the broader, more fundamental phases in the university, leaving much of learning and most of the so essential practical experience with both insects and men (the latter by no means unimportant) to be gained by practise, preferably under the direction of one intimately acquainted with the many duties and privileges of the economic entomologist.

Tetranychus mytilaspidis Riley in New York: During the summer of 1915 a species of red spider was very abundant on apples and pears, growing on the grounds of the New York Experiment Station at Geneva. Specimens of the spiders were sent by Dr. H. Glasgow of this Department to Prof. H. E. Ewing of the Iowa Agricultural College for identification, who replied that the species was the Citrus Red Spider (*Tetranychus mytilaspidis*). This spider, according to Quayle (Cal. Bul. 234: 487), occurs in Florida and California as a pest of citrus fruits. In Oregon it was observed by Ewing on plum, prune and other deciduous trees. As far as is known this is the first record of the occurrence of the pest in the eastern United States.

P. J. Parrott, *Department of Entomology,*
New York Agricultural Experiment Station, Geneva, N. Y.

Obituary

FRANCIS MARION WEBSTER

Economic entomology has suffered a severe loss in the sudden death, January 3, 1916, of Francis Marion Webster, head of the division of cereal and forage crop insect investigations in the United States Bureau of Entomology. He was attacked by pneumonia while in attendance upon the national scientific meetings held during the Christmas holidays at Columbus, O., and died of heart failure within four days.

His record as an entomologist is probably unparalleled in this country as an example of unusual success and usefulness won against heavy initial handicaps. Born in New Hampshire in 1849, he came, when four years of age, with his parents to De Kalb county in northern Illinois, where he passed his boyhood on a farm. The death of his father when he was fifteen years old left him largely to his own resources, and he had little formal education. Marrying at twenty-one years of age, he supported himself by manual labor in the town of Sandwich for a few years, after which he bought a farm in his home county, and lived there for the eight years following. A native bent for the observation of nature had inclined him to the collection and study of insects, especially Coleoptera, in which he developed an interest and enthusiasm which led him, in the fall of 1881, to seek for an opportunity to devote his life to entomology. "There are but two ways of becoming a naturalist," he wrote, "one, to cheat yourself out of sleep and Sundays, which is the way I have been doing for ten years, and the other, getting scientific employment, as I wish to do now."

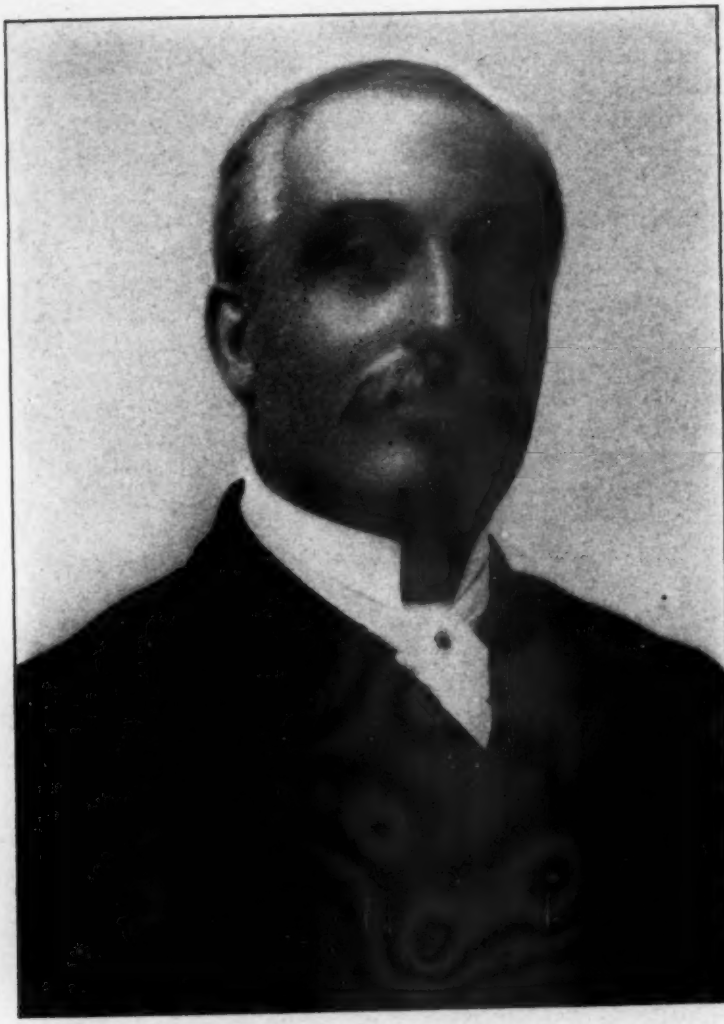
He had already begun to publish brief papers on insects in the *Prairie Farmer*, of Chicago (1879); in the Bulletin of the Brooklyn Entomological Society (1879 and 1881); in the *American Entomologist* (1880); and in the Bulletin of the Illinois State Laboratory of Natural History (1880). The last of these articles, upon the Food of Predaceous Beetles, especially showed the traits for which he afterwards became well and widely known—in its evidence of close, acute, and thoughtful observation and of wide and attentive reading, and in the flavor of individuality which made his speech and writing interesting, on whatever topic.

It was by his engagement, in October, 1881, as an assistant in the Illinois State Laboratory of Natural History, then located at Normal, that the way he was seeking was opened to him when he was thirty-two years of age; and he came there, with his wife and two children, the following February, bringing with him his personal collection of

about twenty-five hundred named species of insects. The spirit in which he thus entered upon his long career of public service is shown in his letter of acceptance, in which he says: "I am not aiming to make money by just so much work for so much pay. I shall throw into the work all the zeal and thoughtfulness at my command; and as to the Laboratory, I feel like a partner in that already."

With the practical union of the Illinois State Entomologist's Office and the State Laboratory of Natural History in July, 1882, Webster became virtually an assistant to the State Entomologist; and the first published product of his work in this new relation was an article on the Angoumois grain-moth and its parasites, printed in the Twelfth Report of the Entomologist's Office.

In the summer of 1884 he was appointed to the United States service as field agent of the Division of Entomology under Riley, and was assigned for investigation the subject of the wheat insects, on which he had already made a substantial beginning. Studying first in Illinois, he was presently sent to Oxford, Ind., and thence to La Fayette in the fall of 1884. Here he made his headquarters for seven years as a special agent of the United States Department and nominal entomologist of the Indiana Agricultural Experiment Station, with which he worked in coöperation. He reported during this period mainly on the insects of the cereal crops, but he spent the early parts of several years between 1886 and 1891 in the south, chiefly in Louisiana and Arkansas, investigating the prevalent species of *Simulium* known as buffalo-gnats and black flies. From December, 1888, to April, 1889, he was on a voyage to Australia (extended to include Tasmania and New Zealand also), whither he was sent to report on the agricultural features of the Melbourne Exposition. For a year from July 1, 1891, he was stationed at Columbus, O., coöperating with the Experiment Station there, as he had done in Indiana; and when a reduction of appropriations compelled the discontinuance of his national work he remained with the Ohio station as its entomologist, accompanying it on its transfer to Wooster. It was during his residence in Ohio that he received from Ohio University (Athens) the honorary degree of master of science. Executive relations finally becoming difficult, he withdrew from the Ohio service in 1902, and returned to Illinois to resume his old relationship on the staff of the State Laboratory of Natural History, which had been transferred in the meantime to the University of Illinois at Urbana. Finally, in July, 1904, he entered on the last phase of his career as a special field agent again of the United States Bureau of Entomology, and, with the division of the Bureau into definite sections in 1906, he was advanced to the position which he occupied at the time of his death. Here as his



F. M. Webster

force was enlarged and his appropriations were gradually increased, he organized and directed one of the largest and most efficient of the divisions of the national entomological service; and this is only another way of saying that he had under his control one of the most important agencies of entomological investigation in the world.

During the thirty-four years of his service, besides inspiring, training, and assisting many young men, he contributed more than three hundred papers to the literature of his subject; and it is not too much to say that our accurate knowledge of the entomology of the forage and cereal crops, especially of the small grains, is in very large measure the product of his personal work. He was not by any means a narrow specialist, but was even more interested in the larger aspects and the remoter bearings of his problems than in their special details. The subject of the distribution, migration, and diffusion of insects especially engaged his attention; and he encouraged his assistants to work out not only the detailed life-histories of the forms they studied, but their anatomy and even their embryology also. He was nevertheless a thoroughly practical entomologist, held in close contact with the soil and the crop by the fact that he had been himself a farmer, and was financially interested in farming all his life.

As an executive he was a good judge of men and a careful, thoroughgoing, and persistent manager; and he gradually brought together in his large division a corps of capable young workers to whose training for their special tasks he gave close and helpful attention. In his relations to them he was critical but kindly, a wise and friendly adviser who attached his subordinates to him by bonds of loyalty and personal affection. "He was almost a father to all of us," one of them has lately said, "and was always looking out for our interests." Although something of a "fighter" in the better sense of the word, he was never a bitter partisan, and he was especially notable for his unswerving loyalty to those who had in any way helped or befriended him.

The high esteem in which he was held by his scientific associates is shown by the fact that, although an economic entomologist especially, he was chosen president of the Entomological Society of America at its Columbus meeting only a few days before his death.

He is survived by his wife, Maria A. [Potter] Webster (to whom he was married at Sandwich, Ill., in August, 1870), and by their two daughters and three sons.

STEPHEN A. FORBES.

SVEN LAMPA[1]

BORN 1839; DIED December 2, 1914

Sven Lampa was the first official representative in Sweden of economic entomology; he was one of the founders of the Swedish Entomological Society in 1879, which as one of its principal objects had the development of economic entomology in Sweden; he was during the years 1891–1901 the editor of the well known periodical of this Society *Entomologisk Tidsskrift* and was in 1908 elected honorary member of the Society. From 1879 to 1897 Sven Lampa had a scientific position at the entomological division of the State Museum in Stockholm; he made, however, during that period also several trips to different parts of Sweden to study in the field attacks of economically important insects. When the government in 1897 founded an institution for economic entomology, Sven Lampa was chosen as its chief without any competition and he held this position for twelve years till he, 70 years old, retired, 1907. His considerable knowledge, his common sense, his kindness and modesty gave him a great personal popularity, which contributed very materially to create general interest for economic entomology in Sweden. In *Entomologisk Tidsskrift*, 1915, has been published his biography by Chr. Aurivillius, his portrait and a list of his 210 publications.

A. BÖVING.

Reviews

The Embryology of the Honey-Bee, by JAMES ALLEN NELSON, Ph. D., Expert, Bee Culture Investigations, Bureau of Entomology. Published by the Princeton University Press, 1915, pp. 1–282, with 95 text fig. 2, and 6 pls.

No domesticated animal has received more detailed and more loving study than has the honey-bee. Apiculturists as a group are broadly interested in the habits and behavior, the structures and the physiology of their charges, a fact well illustrated by the popular texts and the periodicals devoted to the subject. In spite of the wealth of data which have been accumulated, much fundamental work remains to be done, and American science is to be congratulated that this is being undertaken so thoroughly by the Division of Apiculture of the Bureau of Entomology.

One field which has been practically unopened to the student and even to the more technical worker, is that of the embryological development of the honey-bee. Aside from a handful of scattered papers in foreign and inaccessible literature, practically nothing has been known of the subject, in spite of the fact that it is not only of interest in itself but that it may throw important light upon other problems connected with bees and beekeeping. Indeed, aside from Wheeler's magnificent mono-

[1] Extract from Chr. Aurivillius: Sven Lampa, Entom. Tidsk. Vol. 36, 1915, p. 268-281. (Böving.)

graphs of some twenty-five years ago, based primarily on a study of the Orthoptera, and the translation of Korschelt and Heider, long since out of date in important features, the American student has had available practically nothing dealing broadly with insect embryology. This lack is met in a most admirable manner by the work before us.

Dr. Nelson has given us far more than a restricted study of the embryology of the honey-bee. In clear and lucid language, illustrated by numerous and carefully selected figures, he has presented a comparative discussion which may well serve as an introduction to the study of the general subject of insect embryology. Its value in this respect is very greatly increased by a detailed discussion of the methods employed, technique which is adaptable to the study of other forms. An excellent bibliography is also included.

This is not the place to discuss the more technical aspects of the book. Many new details are brought out, and many debatable questions are handled in an impartial and scholarly manner. It is a little disappointing not to find others—notably the question of the origin of the sex glands—more definitely settled, but one should not expect too much.

On the whole the author deserves hearty congratulations and the gratitude of all who may have to deal with the subject of insect embryology. It is a shame that a narrow publication policy has compelled Dr. Nelson to place his work in the hands of private publishers and has deprived the Bureau of Entomology of putting out directly a monograph which would have been a standing credit to it (*Advertisement*).

W. A. R.

Beekeeping, A Discussion of the Life of the Honeybee and of the Production of Honey. By E. F. PHILLIPS, PH. D., Bureau of Entomology, Washington, D. C., pp. i–xxii, 1–457, 190 figures, 1915. Rural Science Series, The Macmillan Company, New York, $2.00 net.

In preparing a book of limited size on a subject of which the author has a broad understanding, he is under the necessity of selecting not only his material, but his method of presenting it. In either case the class of readers addressed must be considered.

Although Phillips has addressed his book on "Beekeeping" to "American beekeepers," a perusal of its pages shows that the term is here applied, not only to all persons interested in bees, but more particularly to those who have had special training in entomology.

With the present rapid development of interest in beekeeping instruction and investigation in American colleges, the appearance of this book is most timely.

Since bees are not domesticated and can scarcely be said to be kept in captivity, their successful management is based entirely on a knowledge of their behavior under the varying conditions of season and locality. The application of this knowledge to practical management requires a correct interpretation and continuous control of colony conditions in relation to the season and locality in question.

In his preface the author states that "it has seemed desirable in the early chapters to discuss bees as they exist without man's interference, thus giving the foundation on which the practice of beekeeping rests. The beekeeper is not especially interested in the anatomy of the bee, and, while it is necessary to use illustrations of various organs and describe them briefly, an effort has been made to treat the bee as a living animal and to have the discussion deal with physiology and especially with activities, in so far as investigations have thrown light on these processes. In the preparation

of the chapters devoted to the management of the apiary, an effort has been made to present the various systems of manipulations in such a way that the underlying principles shall be evident, rather than to attempt to describe each system as if it were separate."

According to the author's plan, the book is divided into two main discussions: first, of bees as they exist without man's interference, and second, of how man may profitably use or interfere with natural colony conditions.

The first division occupies chapters 3 to 9, using 171 pages. According to an old phrase in teaching, the author here goes "from the known to the unknown." First taking the colony as the unit, he describes its morphology and physiology in the third and fourth chapters under the headings "Colony and Its Organization," and "The Cycle of the Year." Next, the subdivisions of the colony—the individual bees—are discussed, first in relation to the colony (chapter 5), then as to their own life processes (chapters 6, 7, and 8). Finally, chapter 9 gives the entomological classification of the bee, and the chief characteristics of the different races of honey bees.

Transition is made to the second main division by a discussion of regional differences in the United States with reference to beekeeping in chapter 10. The next two chapters give advice on first steps in beekeeping and apiary management. Then five chapters of only 86 pages give all the directions one finds in the book on bee management, with the exception of a short chapter later on devoted to queen rearing, and one on "The Care of Bees in Winter," which consists mostly of directions for letting them alone. True to his foreword, the author has presented these simple systems of manipulation, so that the underlying principles are evident.

So much then for the main divisions of the book. In addition to these, the first chapter, by way of introduction, discusses beekeeping as an occupation, and the second, one of the shortest, gives a list of the bare essentials of equipment, on the grounds, no doubt, that an art consists not of tools, but of their use. The remaining chapters deal with marketing the honey crop, the production and care of beeswax, the sources of nectar and pollen, bee diseases and enemies, and miscellaneous information. Every one of these chapters is worthy of special mention, but space is limited.

One's first impression of the book is that it is different. No other author has undertaken the subject in just this way. Placing principles first and emphasizing them all the time is fundamentally sound teaching. If there were any adverse criticism it would be that phases of the subject are not followed through from principles to management in the same chapter. For example, the wintering of bees is treated in chapter 4, and the care of bees in winter in chapter 20; but from different standpoints. According to the plan of the book, this is unavoidable.

In clearing away the fog of details of equipment and management, and presenting beekeeping as a scientific art using very simple tools and methods, the author has made a valuable contribution to bee literature.

The style is clear and concise, at times perhaps too condensed for the average beekeeper reader. The illustrations, mostly original, are pen drawings and are splendid. There are 457 pages with 24 chapters, 190 illustrations, and a very complete index. To say that "Beekeeping" is published in Bailey's Rural Science Series by the Macmillan Company, is sufficient commendation of binding, type, and general style of this most excellent publication (*Advertisement*).

M. P.

Scientific Notes

Poison Bran Mash Effective in Destroying Sow Bugs. In one of the sections of the Experiment Station greenhouse where the Department of Botany was carrying on plant breeding experiments, the alfalfa and clover plants were seriously injured by sow bugs. Some of the plants were almost completely destroyed. Sliced potatoes poisoned with Paris green were first tried but did not prove effective. The poisoned bran mash flavored with oranges prepared in the same manner as has been recommended on several occasions by the Kansas Station in the control of grasshoppers, army worms, and cutworms was then tried, and one application, which simply consisted in scattering a small amount of the mash in the evening about the base of the plants, killed practically all of the sow bugs.

GEO. A. DEAN, *Entomologist,*
Kansas Experiment Station.

Apicultural Courses. In reply to a questionnaire sent to colleges and universities, the following list of colleges teaching Apiculture has been prepared by Morley Pettit: College of Agriculture, Aberdeen, Scotland, John Anderson; Schools of Agriculture, Province of New Brunswick, Canada, H. B. Durost, Woodstock, N. B.; Ontario Agricultural College, Guelph, Morley Pettit; Massachusetts, Dr. B. N. Gates, Amherst, Mass.; New York, Cornell University, E. R. King, Ithaca, N. Y.; South Carolina, A. F. Conradi, Clemson College, S. C.; Tennessee, G. M. Bentley, Knoxville, Tenn.; Mississippi, R. W. Harned, Agricultural College, Miss.; Texas, F. B. Paddock, College Station, Texas; Ohio, Jas. Hine, Columbus, Ohio; Kentucky, H. Garman, Lexington, Ky.; Indiana, James Troop, Lafayette, Ind., and Walter Price; Michigan, F. E. Millen, East Lansing, Mich.; Wisconsin, H. F. Wilson, Madison, Wis.; Minnesota, Francis Jager, St. Anthony Park, Minn., and L. V. France, St. Paul, Minn.; Iowa, Prof. C. E. Bartholomew, Ames, Iowa; Missouri, L. Haseman, Columbia, Mo., and A. H. Hollinger, Columbia, Mo.; Kansas Agricultural College, Geo. A. Dean, Manhattan, Kan.; Kansas University, S. J. Hunter, Lawrence, Kan.; Nebraska, Lawrence Bruner, Lincoln, Neb.; Montana, R. A. Cooley, Bozeman, Mont.; California, Geo. A. Coleman, Berkeley, Cal. If there are any errors or omissions, the writer would like to be advised.

A Democratic Plan. On Nov. 1, 1915, the reorganization of the Division of Entomology of the Minnesota Agricultural College and Experiment Station took effect. The new organization is as follows:

The name of the division is changed to that of Economic Zoölogy. It is divided into four sections: A, Economic Vertebrate Zoölogy, Professor F. L. Washburn in charge, who also conducts Nursery Inspection work and has charge of all work with mill and ware-house insects and with Minnesota Hymenoptera. Mr. Washburn retains his title of Professor of Entomology in the University of Minnesota. B, Spraying and Tree Insects, Associate Professor A. G. Ruggles in charge. C, Field Crop Pests and Parasites, Assistant Professor C. W. Howard in charge. D, Greenhouse and Truck Crop Insects, Assistant Professor William Moore in charge.

The administration of the division lies in the hands of a committee composed of the heads of sections. The Chairman of the committee (an executive position) is appointed annually by the Dean of the College, with the approval of the President of the University and of the Board of Regents. Professor F. L. Washburn was appointed Chairman for the present year. The position of Chairman carries with it that of Entomologist to the Experiment Station and a State law provides that the Station Entomologist shall be State Entomologist.

This organization is rather a remarkable step in the direction of a greater democracy in the management of a University Department and may interest other entomologists.

F. L. WASHBURN.

Current Notes

Conducted by the Associate Editor

Mr. G. G. Schweiss, assistant in entomology at Nevada University, resigned August 1, 1915.

Mr. L. V. France has been appointed instructor in beekeeping at the University of Minnesota.

Dr. W. S. Regan is instructor in entomology in the Massachusetts Agricultural College, Amherst, Mass.

Dr. M. C. Tanquary has been appointed instructor and assistant in entomology at the Kansas College and Station.

Mr. E. B. Blakeslee, Bureau of Entomology, has returned to Washington from his field station, Winchester, Va.

Mr. B. R. Leach, Bureau of Entomology, returned to Washington from his headquarters at Winchester, Va.

Mr. D. L. Van Dine, Bureau of Entomology, visited Washington near the end of November and remained several weeks.

Mr. F. L. McDonough, Bureau of Entomology, completed the determination of the boll weevil dispersion in Florida during November.

Mr. L. M. Gates, field expert in entomology at the University of Nebraska, has resigned to engage in farming.

Mr. A. H. Jennings, Bureau of Entomology, was absent on furlough for the month of December on account of ill health.

Mr. B. P. Young, a graduate student, has been appointed instructor in entomology at the University of Kansas. His work will be along morphological lines.

Mr. P. W. Claassen, Assistant State Entomologist at the University of Kansas during the past two years, is now Research Assistant at Cornell University.

Dr. Henry Fox, Bureau of Entomology, who was stationed temporarily during the summer at Tappahannock, Va., has returned to his field station at Charlottesville, Va.

Mr. C. C. Hamilton, Bureau of Entomology, temporarily engaged at Rocky Ford, Colo., has reëntered the University of Illinois, Urbana, Ill.

Mr. C. P. Clausen has been appointed assistant superintendent of the State Insectary at Sacramento, Cal., vice H. L. Viereck, resigned, and has entered upon his duties.

Dr. T. J. Headlee, New Brunswick, N. J., has been appointed entomologist of the Society of American Florists and Ornamental Horticulturists for the coming year by President MacRorie.

Mr. V. L. Wildermuth, Bureau of Entomology, who visited Washington in the fall while engaged in the preparation of manuscript, has returned to his field station at Tempe, Ariz.

The cranberry insect laboratory of the Bureau of Entomology, formerly at Pemberton, N. J., in charge of Mr. H. B. Scammell, has been transferred to Brown's Mills, N. J.

J. D. Smith and J. U. Gilmore, Bureau of Entomology, who arrived in Washington on November 4, were compelled to return to their homes on November 27 on account of illness.

Mr. R. N. Wilson, Bureau of Entomology, who spent a part of November in the office at Washington preparing manuscript, has returned to his field station at Gainesville, Fla.

At the Annual Meeting, December 10, Mr. George H. Hollister was elected president of the Connecticut Horticultural Society at Hartford. Mr. Hollister is now superintendent of Keney Park in Hartford.

Mr. J. Turner Brakeley, a student of mosquitoes, co-worker and friend of the late Dr. John B. Smith, died recently at his home, Lahaway Plantations, N. J., aged sixty-eight years.

Mr. Irving R. Crawford, Bureau of Entomology, temporarily attached to the range caterpillar investigations at Maxwell, N. M., has resigned from the service in order to engage in other work.

Mr. R. A. Cushman, Bureau of Entomology, of the North East, Pa., laboratory, has returned to Washington and will be engaged during the winter in monographic work on parasitic Hymenoptera.

Mr. A. I. Fabis, Bureau of Entomology, connected with the laboratory at Monticello, Fla., engaged in pecan insect investigations, has returned to Washington for the purpose of conference and library work.

According to *Experiment Station Record*, Mr. D. T. Fullaway resigned June 30, 1915, as entomologist of the Hawaii station to become field entomologist of the territorial board of agriculture and forestry.

The connections of temporary appointees in the Bureau of Entomology, Messrs. C. H. Alden, W. B. Cartwright, and H. L. Dozier, have been severed on account of expiration of the periods for which they were employed.

In the work on the potato-tuber moth, which has been carried on for some time by the Bureau of Entomology, thirteen parasites and one hyperparasite have been studied by Mr. John E. Graf.

Mr. Dwight Isely, Bureau of Entomology, has returned to Washington from the North East, Pa., laboratory, where special attention was given during the summer to field experiments in the control of the grape-berry moth.

Mr. H. H. Kimball, Bureau of Entomology, returned to Agricultural College, Miss., from New Orleans on the 15th of November. He will make a local malaria mosquito survey of the vicinity of the College during the winter.

Mr. E. H. Siegler, Bureau of Entomology, who is engaged in investigations of the codling moth in Grand Junction, Colo., has arrived in Washington and will be engaged during the winter in the preparation of notes, manuscripts, etc.

Mr. Samuel D. Gray has been appointed professor of entomology at the Porto Rico College, vice R. I. Smith, whose resignation to take up quarantine work for the Federal Horticultural Board was announced a few months ago.

According to *Science*, a biological expedition to the island of Santo Domingo will be made next fall by Professor J. G. Needham, and Messrs. J. T. Needham, Ludlow Griscom and K. P. Schmidt of the entomological department of Cornell University.

The Annual Massachusetts convention of beekeepers will be held at Amherst, Mass., March 14 to 16, inclusive. This convention will conclude the winter school of beekeeping at the Agricultural College.

Professor Geo. A. Dean, of the Kansas State Agricultural College, Manhattan, Kan., will offer the courses of instruction in entomology in the second term of the Summer Session, at the University of Kansas, Lawrence, Kan.

Mr. Geo. H. Vansell resigned his position on the staff of the State Entomologist of the University of Kansas, on December 1, to accept the position of assistant professor of entomology at the University of Kentucky.

Mr. Fred W. Poos, Jr., a graduate student of the University of Kansas, takes the place on the staff of the State Entomologist made vacant by the resignation of Mr. Vansell.

According to *Science*, Assistant Professor A. L. Lovett has been made acting head of the entomological department of the Oregon Agricultural College, vice H. F. Wilson, who resigned recently to accept a professorship in entomology at the University of Wisconsin.

Entomological News announces the death of Dr. Frederick W. Russell, formerly of Winchendon, Mass., on November 20, 1915, at the age of 71. Dr. Russell was particularly interested in the Lepidoptera and for years collected moths at light at his home in Winchendon.

According to *Science*, Mr. Herbert T. Osborn, a graduate of Ohio State University in 1909, and son of Professor Herbert Osborn, has been sent by the Sugar Planters' Association of Honolulu to Formosa to secure parasites to use in Hawaii to control the cane beetle.

Mr. E. W. Geyer, Bureau of Entomology, who spent the summer at Roswell, N. M., in orchard spraying and dusting work, has returned to Washington for conference and for the completion of the report on the life history of the codling moth in New Mexico.

Mr. E. R. Van Leeuwen, who has been assisting Mr. Siegler in codling moth investigations at Grand Junction, Colo., has been transferred to the Bureau of Entomology field station at Benton Harbor, Mich. Mr. Van Leeuwen will shortly leave the service to resume his college studies.

Mr. Henry L. Viereck, who recently resigned from the California State Insectary, for a few weeks in November was at the American Museum of Natural History, New York City; he is now connected with the Bureau of Biological Survey, U. S. Department of Agriculture, Washington, D. C.

According to *Entomological News*, M. Charles Kerremans, a student of the Buprestidæ in Europe, died October 10 at the age of 68. Mr. Kerremans was engaged in the preparation of a monograph of this family of beetles, which had not been completed at the time of his death.

Entomological News records the death, on November 16, 1915, of Professor Raphael Meldola of London, England, aged 66. Professor Meldola was the author of many entomological papers and a member of several scientific societies. In 1895 and 1896 he was president of the Entomological Society of London.

According to *Science*, King Ferdinand of Bulgaria has been removed from membership in the Entomological Society of France, which he has held since 1882, and in the Petrograd Entomological Society. The latter has elected in his place M. Lameere of Brussels, who is now working in the Paris Museum of Natural History.

Mr. Curtis P. Clausen, Assistant Superintendent of the State Insectary at Sacramento, Cal., sailed for the Orient on January 8, for the purpose of collecting parasites and predators for use against scale insects injurious in California. His field will be Japan and Formosa, and possibly China later.

Mr. J. W. Bailey, Bureau of Entomology, who has had experience with Mr. M. M. High in onion insect investigations at Brownsville, Tex., and who has been a collaborator during the year at Starkville, Miss., entered Cornell University at the beginning of the college year, to complete his course in entomology.

The Michigan Agricultural College announces a short course or "beekeepers' week," March 13 to 18. Both men and women are welcome. There are no fees and no age limits. Mr. F. Eric Millen is instructor in beekeeping and also State Inspector of Apiaries.

Mr. George B. Merrill, recently connected with the Gipsy Moth Laboratory at Melrose Highlands, Mass., has accepted the position of Deputy Port and Railway Inspector with the State Plant Board of Florida. Mr. Merrill will be stationed at Tampa.

Mr. A. C. Mason, until recently connected with the Nursery Inspection work in Florida, has been appointed as Assistant to Dr. E. W. Berger, entomologist of the Florida Plant Board, and will be located at the Plant Board laboratory at Gainesville.

G. E. Bensel, collaborator, Bureau of Entomology, has been appointed Supervising Agriculturist of all of the Southern California Sugar Companies for the purpose of improving the present cultural method of the sugar beet crop, and to supervise the combating of various enemies affecting this crop, especially nematodes. His headquarters are Los Angeles, Cal.

Mr. Donald J. Caffrey of the Bureau of Entomology, stationed at Maxwell, N. M., visited Washingtou in December and January and spent his vacation at his home in Massachusetts. On his return he visited the entomological department of the Agricultural Experiment Station at New Haven, Conn., where he was formerly an assistant.

Professor Gordon M. Bentley, formerly State Entomologist and Pathologist of Tennessee, has been reinstated. It was announced in the last number of this JOURNAL that Governor Rye had refused to reappoint Professor Bentley. It seems that instead he appointed a nurseryman, Mr. Bing of Smithville, and the office was removed to Smithville. Mr. Bing has now resigned and Professor Bentley has been reappointed to his former position.

Professor James G. Needham of Cornell University visited the University of Kansas, Lawrence, Kan., in November, and delivered an address before the entomological club on "The Ecology of Certain Aquatic Larvæ," and also spoke before all students of biology on "The Common Ground of Poet and Naturalist." A smoker was given in the evening in honor of Professor Needham and to enable the University men to meet him.

According to the *Experiment Station Record*, contracts have been awarded for the new biology building at the University of Nebraska, which will house the departments of botany and zoölogy and will bear the name of Bessey Hall. The structure will consist of a three-story and basement main building, 235 x 75 feet, with a short wing at each end and attached greenhouses and vivaria, and will cost approximately $200,000.

Mr. George H. Corbett of Trowbridge, Wiltshire, England, who was in the United States last year as a Carnegie student, has offered his services to his country for entomological and hospital work at the front. While in this country Mr. Corbett visited many official entomologists and experiment stations in the United States and Canada and he wishes to express publicly in the JOURNAL OF ECONOMIC ENTOMOLOGY his gratitude to all entomologists who gave him so much valuable assistance while here.

The Florida Entomological Society has recently been organized at Gainesville, Fla., with fifteen charter members. The first officers elected were: Prof. J. R. Watson, Entomologist of the Florida Experiment Station, president; Mr. Wilmon Newell, Plant Commissioner of the Florida Plant Board, vice-president; and Mr. R. N. Wilson, U. S. Bureau of Entomology, secretary-treasurer. A paper was read on the Velvet Bean Caterpillar (*Anticarsia gemmatilis*), by Professor Watson, and another on the Fungous Diseases of Scales and White Flies on Citrus, by Dr. E. W. Berger, Entomologist of the Florida Plant Board.

In the District of Columbia, Dr. F. H. Chittenden of the Bureau of Entomology has found that the abutilon moth (*Cosmophila erosa*) has not appeared on abutilons at all; a few have been found on hollyhocks; and four individuals were taken from morning-glory. Two of these looked perfectly healthy when received, were full-grown, and had the characteristic markings on the back. All four died owing to the attack of the minute egg-parasite (*Litomastix* (*Copidosoma*) *truncatellum*. This latter species has been very abundant during the year and has perhaps been more instrumental in keeping down the numbers of the cabbage looper (*Autographa brassicæ* Riley) than any other single cause.

Mr. D. J. Caffrey, Bureau of Entomology, reports the recovery of the parasitic fly, *Compsilura concinnata*, from specimens of the range caterpillar taken at a point where a colony of the fly was liberated during the summer of 1914. This apparently indicates that the parasite has become established. Mr. Caffrey also reports the range caterpillar as injuring seriously corn and other cultivated crops in the vicinity of Maxwell, N. M., during the past summer. The insect has heretofore confined its attentions almost exclusively to the blue gramma grass of the cattle ranges.

In coöperation with the Office of Home Economics of the States Relations Service, a series of experiments are being conducted by the Bureau of Entomology with a colony of bees placed in a respiration calorimeter. The object of these experiments is to determine the exact quantity of heat given off by the bee colony under different

conditions in regard to the temperature, humidity, and the carbon dioxid and oxygen content of the surrounding air. The water vapor and the carbon dioxid given off by the bees under these different conditions are also determined. Mr. W. A. Parks of Washington, D. C., has been appointed as student assistant and assigned to this work.

Mr. Neale F. Howard, Bureau of Entomology, who has been working on root maggots and other insects at Green Bay, Wis., has entered Ohio University, Columbus, Ohio, for a postgraduate course, under the direction of Professor Herbert Osborn. Mr. Howard reports that tarred felt pads, first invented by Goff, have been used by some of the gardeners in the vicinity of Green Bay since the early 90's and with perfect success. When made of the right material and properly placed the percentage of efficiency is practically 100. It is not applicable to cabbage in seed beds, but if it could be adapted to the control of the onion maggot, a near relative, it would be an ideal method.

Science states that the equipment of the department of entomology at the University of Illinois, and of the natural history survey of that state, receives a notable addition in the new vivarium building in Champaign, which will contain a large insectary for student use, with three laboratory rooms in connection, an apparatus, furnished conjointly by the university and the State Laboratory of Natural History, for temperature and humidity control in the study of insect life-histories, and a set of experimental aquaria fitted up for exact studies on the ecology of fresh-water animals. The insectary and entomological laboratories will be under the charge of Dr. R. D. Glasgow, and the state laboratory equipment under that of Dr. V. E. Shelford, of the laboratory staff.

The following note was printed in *Science:* "At the two hundred and ninety-first regular meeting of the Entomological Society of Washington the constitution was amended so as to permit the election of an honorary president, such office to be tendered only to active members who have been especially prominent in the affairs of the society and to convey with it expressions of gratitude, respect and honor. After creating this office, the society elected unanimously Mr. E. A. Schwarz as first honorary president. Mr. Schwarz was one of the charter members of the society, has held the office of president for two terms, vice-president for a number of terms, and secretary for a number of terms and has taken an active interest in the affairs of the society. He has attended every meeting of the society when he has been in Washington, has contributed greatly to its financial support and has entertained the society more than any other member. He is an internationally recognized authority on Coleoptera and has contributed materially to the advancement of his favorite group and also to the general science of entomology."

The following note occurs in the November *News Letter* of the Bureau of Entomology: In a memorandum to this office dated November 6, 1915, Dr. W. D. Hunter, in charge Southern Field Crop Insect Investigations, stated: "The recent hurricane injured practically every building in New Orleans, La., more or less, and hundreds were completely demolished. . . . Many of the exposed beams were mined by insects and in many cases at least this weakening of the timbers was an important contributory cause of the loss." The insects usually responsible for this type of injury are termites and "powder post" beetles. Damage to timbers of buildings by termites is occasionally serious even in the northern states. "Powder post" beetles also often seriously injure the beams of buildings. But this is the first instance of the interrelation of storms and insects in the destruction of buildings

that has come to our notice, although similar interrelation between insects and storms in the destruction of telephone and telegraph poles has been commonly noted. We will be glad to receive specimens of the insects or insect-damaged wood from buildings in the region of the storm above referred to.

Mr. S. A. Rohwer of the Bureau of Entomology has just completed a summary of the first year's growth of the nursery connected with the Eastern Field Station. This nursery now consists of twenty-three species of deciduous trees which are represented by one hundred and thirty specimens. There were one hundred and thirty-nine planted, which makes a loss of nine. Of these one hundred and thirty trees, eleven are at present used in experiments to determine the life-history of insects injurious to forest trees. Some very useful experiments are being carried on with trees of *Robinia pseudacacia* to determine the life-history of *Ectydolopha insiticiana*. These experiments are under the direction of Mr. Heinrich. The coniferous nursery is composed of three species of *Abies*, two species of *Larix*, three species of *Picea*, fifteen species of *Pinus* and one species of *Pseudotsuga*, a total of twenty-four species. There were twenty-one hundred and ninety-nine coniferous trees planted. Of these, fourteen hundred and sixty-six are living, which means a loss of 33⅓ per cent. Thirty of the coniferous trees are now used in experiments. Most of these experiments are for various species of *Evetria* and *Diprion*. Some of the coniferous trees which have done especially well are *Pinus ponderosa*, *recinosa*, *sylvestris* and *divaricata*. The two species of *Larix* show marked difference in their adaptibility to eastern conditions. In the plot of *Larix occidentalis* there are only ten trees living, ninety-two having been killed by the summer. In the plot of *Larix leptolepis* (Japanese larch) there are sixty-five living trees and some of these have made phenomenal growth.

At a meeting in New York City, November 17, there was formed the Interstate Anti-Mosquito Committee, consisting of two members each from New York City, Nassau and Westchester counties, and the adjoining states of Connecticut and New Jersey. This committee held a meeting at the offices of the Department of Health, New York City, January 12, 1916, and mapped out a program for work. Its membership is as follows:

New York City: Dr. Haven Emerson, Health Commissioner, Mr. Samuel Eckman, Forest Hills, N. Y.

Westchester County: Dr. A. Hoyt, New Rochelle, N. Y., Mr. Collin Armstrong, Scarsdale, N. Y.

Nassau County: Dr. Frank Overton, Patchogue, L. I., Mr. W. J. Matheson, Huntington, L. I.

New Jersey: Dr. Thomas J. Headlee, State Entomologist, New Brunswick, N. J., Dr. Ralph H. Hunt, East Orange, N. J.

Connecticut: Dr. W. E. Britton, State Entomologist, New Haven, Conn., Dr. Valery Havard, U. S. A. (Retired), Fairfield, Conn.

Mailed March 4, 1916